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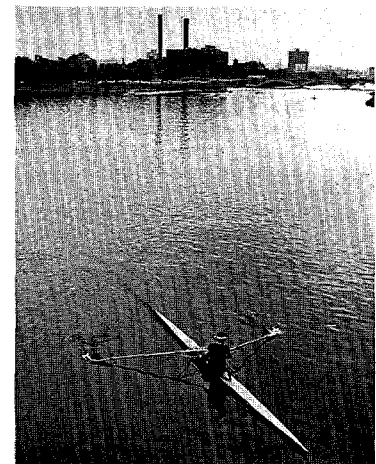
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Report of the Southeastern New England Study



a Strategy for Balanced Development
and Protection of Water and Related
Land Resources in Eastern
Massachusetts and Rhode Island

8. PAWTUXET PLANNING AREA REPORT

COASTAL ZONE
INFORMATION CENTER

New England River Basins Commission

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New England River Basins Comm.

The Southeastern New England Study (SENE) is a "level B water and related land resources study." It was conducted under the provisions of the federal Water Resources Planning Act of 1965. The resources management program the Study produced was developed by a team of federal, state, and regional officials, local citizens, and the scientific community, under the overall coordination of the New England River Basins Commission. It is a part of the Commission's comprehensive, coordinated joint plan for the water and related land resources of New England.

The recommended program for managing the resources of Southeastern New England is described, in increasing level of detail, in the following Final Reports:

A SUMMARY highlighting the principal findings and recommendations of the Study, and their implications for the future of the region.

A REGIONAL REPORT and Environmental Impact Statement describing *in detail* the natural resources, issues and problems facing the region, the alternative solutions examined during the Study, the recommendations made, and their implications. It includes policies and programs for dealing with water supply, land use, water quality, outdoor recreation, marine resources, flood and erosion protection, and key facilities siting, and the changes in state and local government required to implement the program.

Ten PLANNING AREA REPORTS dealing with the same subjects as the Regional Report, but aimed at the local level. Eastern Massachusetts and Rhode Island were divided into ten "planning areas" based either on traditional sub-state divisions or principal river basins. Reports were prepared for the following areas:

1. Ipswich-North Shore,
2. Boston Metropolitan,
3. South Shore,
4. Cape Cod and the Islands,
5. Buzzards Bay,
6. Taunton,
7. Blackstone and Vicinity,
8. Pawtuxet,
9. Narragansett Bay and Block Island,
10. Pawcatuck

Other reports prepared during the course of the Study include the following:

Inventory Reports

For each of the ten planning areas, inventory reports were prepared covering the following subjects: climate, meteorology, hydrology, geology; land use, patterns, allocations, and management; special environmental factors; water supply; ground water management; water quality control; outdoor recreation; fish and wildlife; navigation; flood plain zoning and streamflow management; inland wetlands management; coastal resources; irrigation and drainage; sediment and erosion; power; minerals.

Special Reports

In addition to inventory reports, over a dozen special reports were prepared, including: Socio-Economic and Environmental Base Study, Volumes I and II; Economic analyses of water supply and demand issues, power plant siting, coastal resources allocation, and sand and gravel mining; Legal and institutional analyses of the state wetlands laws, arrangements for water supply service, fiscal policy and land control, access to natural resources areas, and management structure for water and land use issues; Urban Waters Special Study; Summaries of public workshops

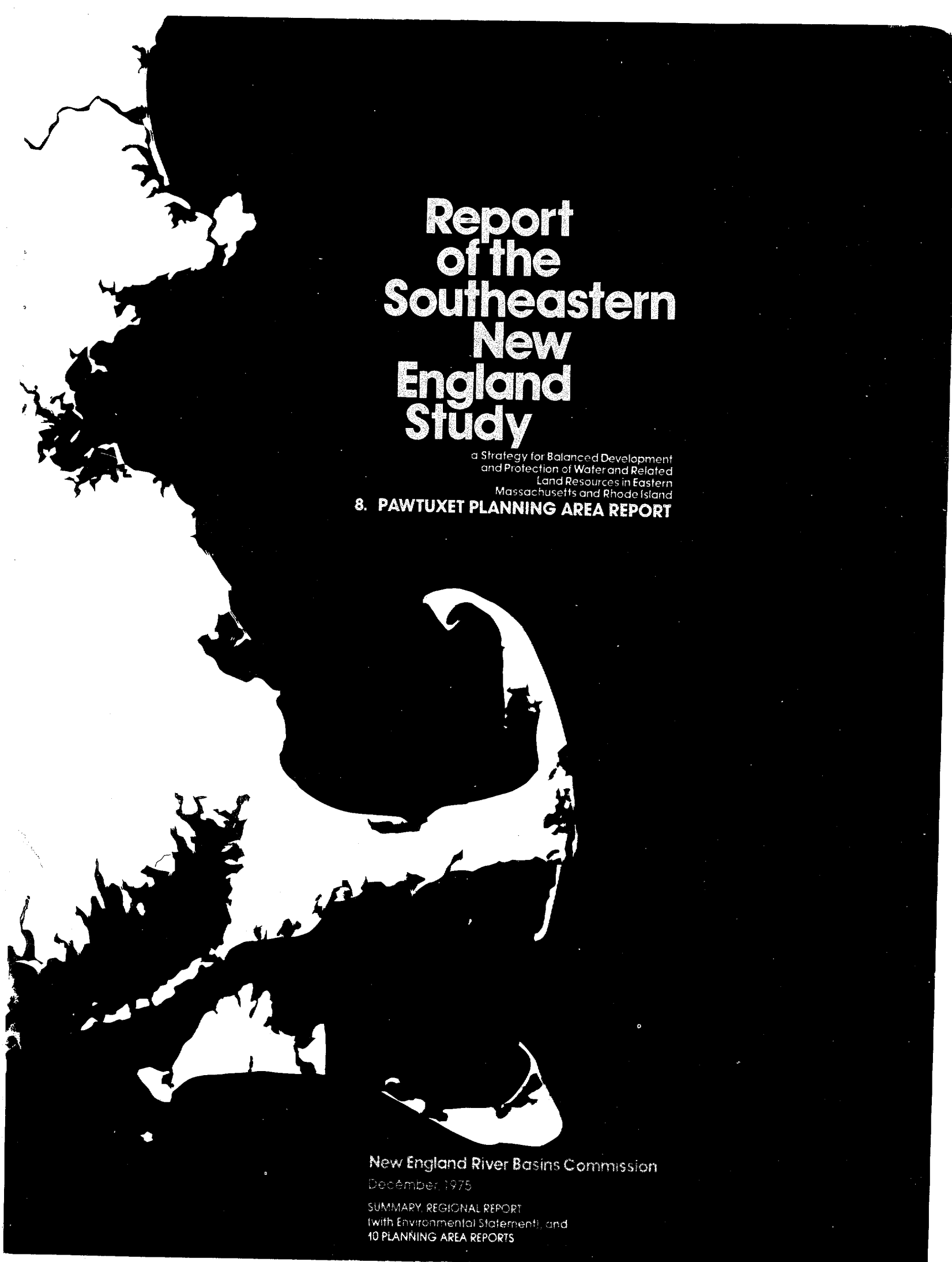
Copies of reports are available from:

New England River Basins Commission
55 Court Street
Boston, Massachusetts 02108

National Technical Information
Service
Springfield, Virginia 22151

and also in each of the 208 libraries and 210 town halls throughout the SENE region.





Report of the Southeastern New England Study

a Strategy for Balanced Development
and Protection of Water and Related
Land Resources in Eastern
Massachusetts and Rhode Island

8. PAWTUXET PLANNING AREA REPORT

New England River Basins Commission

December, 1975

SUMMARY, REGIONAL REPORT
(with Environmental Statement), and
10 PLANNING AREA REPORTS

REPORT OF THE SOUTHEASTERN NEW ENGLAND STUDY

READER'S GUIDE: HOW TO REVIEW THIS REPORT

- In five minutes

FOR A "THUMBNAIL SKETCH"

Read the **OVERVIEW** which folds out as one large sheet. There is an extra copy in the pocket in the rear for those who would like to mount it on the wall.

- In a half hour or less

TO LEARN THE MAIN POINTS

Read the **SUMMARY**. It is published separately. You can read it in either of two ways:

- **SELECTIVELY**. Read the Chapters on Goals and Approach and Guiding Growth, plus any others that interest you. Chapters are boldly labeled to facilitate selective reading; or

- **ENTIRELY**. Read the full summary for a fuller understanding of the highlights of the SENE Study.

- In one day or less

TO UNDERSTAND THE DETAILS

Read the **REGIONAL REPORT**.

- **SELECTIVELY**. It is organized exactly like the summary. Wherever your interests lie, you can turn to those sections for additional background, amplifications, analysis of rejected alternatives, and especially for the full text of each recommendation, including who should do what and when. Also, remove the Development Capabilities Maps in the rear pocket and examine the legend to appreciate the type of information the maps portray; or

- **ENTIRELY**. Read the full report for full appreciation of all recommendations, and how they interrelate.

- In an additional 10 minutes to 2 hours

FOR APPLICATION TO YOUR AREA

Get the **PLANNING AREA REPORT** for your locale. Scan it or read it to see how the broader recommendations presented in the Regional Report may apply to the area where you live or work.

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OVERVIEW

Pawtuxet Planning Area

What is the point of the SENE Study Program?

Balanced use and conservation of the region's water and related land resources is the program's objective. The South-eastern New England (SENE) Water and Related Land Resources Study was authorized and funded by Congress in response to the increasingly troublesome pressures the region's rapid urbanization was exerting on its rich and varied natural resources. The SENE Study has two major goals:

- To recommend actions for all levels of government and private interests to secure for the people of the region the full range of uses and benefits which may be provided by balanced use and conservation of the region's water and related lands.
- To assemble information on the resources at a consistent scale and level of detail.

What makes this Study different is that it covers a relatively large geographic area (4400 square miles), it addresses a full range of water and related land issues, and it proposes coordinated actions for all levels of government and private interests.

What does the SENE Study program cover?

The most important recommendations for this planning area include the following:

- (1) To accommodate growth in environmentally and economically acceptable ways, municipalities should prohibit or restrict development of Critical Environmental Areas such as wetlands, flood plains, and well sites. Growth should be guided to Developable Areas which cover 41 percent of the planning area. Within this category, municipalities should manage development on resources such as steep slopes, ledge, and soils with septic limitations. Development should be encouraged where services already exist or are planned.
- (2) To supply sufficient amounts of water to serve the needs of both the planning area and other water-short areas of Rhode Island, approve the Big River Reservoir project, expand the Providence system, and develop ground water resources.

- (3) To improve water quality, expand and upgrade municipal treatment plants, control industrial discharges, and negotiate an optimal flow regime.
- (4) To meet recreation needs, expand existing facilities, acquire new areas, acquire public access to ponds and streams, and permit low-intensity outdoor recreation on some storage water supply watershed lands.
- (5) To reduce serious flooding damages, prohibit new flood plain development, flood proof existing buildings, and consider small scale projects such as regulation of existing dams and bridge and culvert reconstruction as opposed to large-scale dams and diversions.

What will the program do?

If the recommended actions are carried out, most 1990 needs for water, sewers, electric power, and outdoor recreation could be met by making more efficient use of facilities, legal authorities, and institutional designs. Protecting Critical Environmental Areas will avoid potential dangers to life and property from flooding, erosion, and contamination of water quality; and will provide productive greenbelts. As a result, new growth in this planning area in the SENE region can be accommodated without harming the high quality environment which attracted the growth in the first place.

You can take the first step in helping to carry out the program by reading the recommendations in the SENE Study's Regional and Planning Area Reports. Write your state and Congressional representatives about the Study. Urge your local planning and conservation officials to use the SENE Study planning process when developing or implementing master plans, zoning ordinances such as flood plain and watershed protection, and other water and land use decisions.

RECOMMENDATIONS

GUIDING GROWTH (Chapter 3)

1. Protect priority Critical Environmental Areas.
2. Restrict development on other Critical Environmental Areas.
3. Manage growth on Developable Areas.
4. Use SENE resource development capability analysis to guide future growth.
5. Accommodate growth where services already exist.

WATER SUPPLY (Chapter 4)

1. Petition the General Assembly to approve construction of the Big River Reservoir.
2. Protect the aquifer underlying Cranston and Providence for industrial water supply.
3. Expand Providence Water Supply Board to serve northern Scituate.
4. Develop ground water reservoir in Coventry and West Greenwich to serve Kent County system municipalities.
5. Limit water use or supplement supplies from surface sources in Coventry and West Warwick.

WATER QUALITY (Chapter 5)

1. Continue with expansions of Warwick and Cranston secondary treatment plants.
2. Evaluate treatment options in the West Warwick area.
3. Negotiate an optimal flow regime.

OUTDOOR RECREATION (Chapter 6)

General Outdoor Recreation

1. Develop guidelines for planning low-intensity recreation on lands adjacent to storage reservoirs.
2. Provide picnicking and extensive recreation at John Curran State Park.

3. Develop two regional trails.
4. Acquire access to Kimball Reservoir and Stone Pond.
5. Acquire several parcels at the Flat River Reservoir.
6. Develop a statewide recreational advisory committee.
7. Use Development Capabilities Maps for open space protection programs.

Wildlife and Freshwater Fisheries

8. Improve enforcement of existing wetlands legislation.
9. Acquire the most important wildlife habitats.
10. Acquire public access to 29 ponds.
11. Acquire public access to 11 streams.

MARINE MANAGEMENT (Chapter 7)

See Regional Report, Chapter 7.

FLOODING AND EROSION (Chapter 8)

1. Assess current programs to give non-structural emphasis.
2. Adopt local flood plain zoning to regulate future flood plain development.
3. Establish local sediment and erosion control ordinances.
4. Establish forest buffer zones.
5. Control forest land erosion.
6. Acquire key wetlands and flood plains
7. Locate in existing safe buildings in the flood plain.

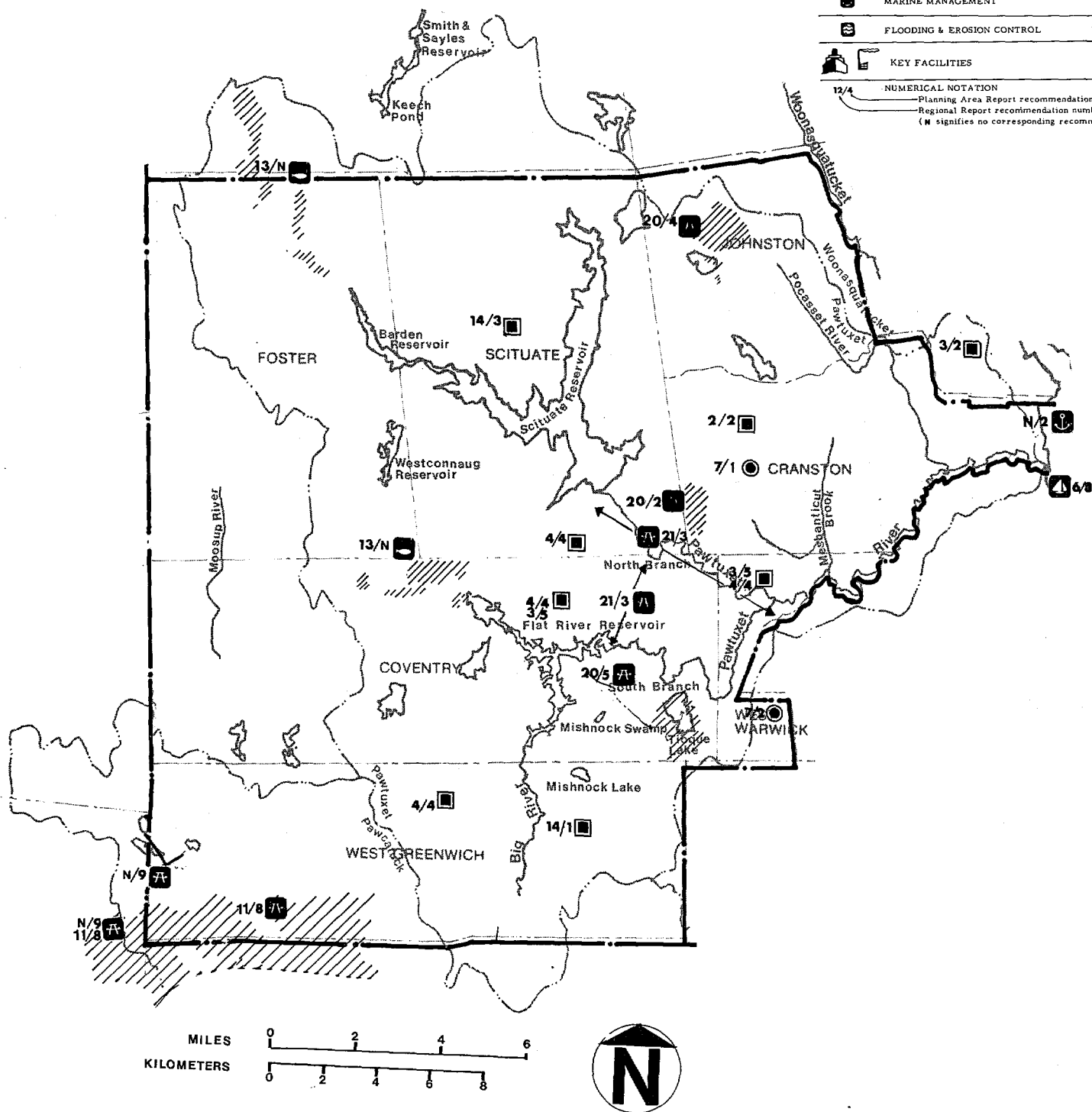
LOCATING KEY FACILITIES (Chapter 9)

See Regional Report, Chapter 9.

The symbols on this map represent the recommended actions that can be shown on a town-by-town basis. The symbols are placed roughly within each town, and are not intended to be more specifically sited than that.

Legend

	WATER SUPPLY
	WATER QUALITY
RECREATION	
	Swimming & Public beaches
	Boating & marinas
	Fisheries & wildlife
	Other recreational activities
MARINE MANAGEMENT	
	FLOODING & EROSION CONTROL
KEY FACILITIES	
	NUMERICAL NOTATION
12/4	
— Planning Area Report recommendation number	
— Regional Report recommendation number	
(N signifies no corresponding recommendation)	



NEW ENGLAND RIVER BASINS COMMISSION
BOSTON, MASSACHUSETTS



SOUTHEASTERN NEW ENGLAND
WATER AND RELATED LAND RESOURCES STUDY

Pawtuxet Planning Area
Recommended Actions

CHAPTER 1 THEMES

This report on the Pawtuxet planning area is one component of a comprehensive program for managing water and related land resources in the Southeastern New England (SENE) region. The Study's Regional Report has presented recommended policies and actions from a regionwide or state wide perspective. This planning area report includes applications of those broad-based recommendations to the cities and towns in the Pawtuxet area.

One reason for preparing planning area reports is to connect the actions at the local level with the policy framework and considerations for state and federal levels. This direction was chosen as a response to the region's long history of local autonomy and to the Study's emphasis of placing decision-making at the level closest to the problem. The planning area boundaries follow the town lines most closely approximating the hydrologic boundaries of river basins.

Three common theses link all the reports:

- **Enhancing the environment enhances the economy.** Preventing degradation of the area's remaining fragile natural resources can both decrease the cost of development to the taxpayer and protect the amenities which are the region's competitive economic advantage.
- **Anticipated growth can be accommodated, but it needs guidance.** There is enough land within the region to accept new growth and still protect Critical Environmental Areas. But that growth must be guided to lands which can support development, and within those lands, to areas already served by essential water, sewer, and transportation services.
- **Existing knowledge, programs, and institutions provide the most realistic tools for achieving results, but some changes are needed.** Full use of ongoing pro-

grams, with some changes in how they relate to each other, was viewed as a way of "piggy-backing" on programs which have already weathered most of the realities of the political process. In choosing this strategy, the Study traded off novelty to increase achievability.

Each major chapter in this report contains actions to solve water and related land problems which we face now or can expect to face in the next 15 years, and in some cases into the next century. Table 1.1 sets out the intensity of these problems within each planning area, between each planning area, and for the region as a whole. Abundant water supply and a relatively high proportion of land still available for development explain why few of the resource problems have been ranked as serious for the planning area relative to the region as a whole. However three chapters reflect major problems for the Pawtuxet region, as shown in Table 1.1.

- **Guiding Growth.** While a relatively high proportion of the area is classified as developable, it may not be enough to accommodate the new growth expected.
- **Water Quality.** Municipal and industrial discharges combined with serious low flow problems make cleaning up the lower Pawtuxet River a major problem, even with advanced treatment techniques.
- **Flooding.** Extensive development in the flood plain, plus a past history of serious flood damages make flooding a major problem, especially along the mainstem of the Pawtuxet River.

Additional important issues are the few opportunities for swimming, limited access to hunting and fishing areas, and the need to assure the preservation of known sand and gravel deposits for future use.

TABLE 1.1 GENERAL INTENSITY OF SENE WATER - RELATED PROBLEMS BY PLANNING AREA

<div>Key</div> <div><div>● Severe problem</div><div>◐ Major problem</div><div>• Moderate problem</div><div>Blank Minor or no problem</div></div>										
	GUIDING GROWTH (Overall)									
	Protection of Critical Environmental Areas		Management of Developable Areas		WATER SUPPLY		WATER QUALITY (Overall)		Land Use Discharges	
					Combined Sewers/Urban-Runoff		Municipal Discharges		Industrial Discharges	
							Low Streamflow		Septic Systems	
									Agricultural Runoff	
									Landfill Leachate	
									Oil Pollution	
									Watercraft Wastes	
									RECREATION (Overall)	
										Swimming
										Boating
										Recreational Saltwater Fishing
										Camping and Picnicking
										Access to Hunting and Fishing Opportunities
										Passive Outdoor Recreation
										MARINE MANAGEMENT (Overall)
										Offshore Fisheries
										Shellfish and Aquaculture
										Port Development
										Offshore Sand and Gravel
										Urban Waterfronts
										FLOODING AND EROSION (Overall)
										Inland Flooding
										Coastal Flooding
										Inland Erosion
										Coastal Erosion
										LOCATING KEY FACILITIES (Overall)
										Availability of Sand and Gravel
										Power Plant Siting
										Petroleum Facilities Siting
										Solid Waste Management
PLANNING AREAS										
Ipswich - North Shore	●	○	●	○	●	○	•	○	•	○
Boston Metropolitan	●	○	○	●	●	●	●	○	○	○
South Shore	○	•	○	•	○			○	•	
Cape Cod and the Islands	○	●	•	○	•		●	•		
Buzzards Bay	•	●			○	●	○	○		
Taunton	○	●	•	○	●	●	●	○	•	
Blackstone and Vicinity	●	•	●	●	●	●	•	•	○	○
Pawtuxet	○	•	•		●	●	•			
Narragansett Bay	○	●	●	○	○	●			○	
Pawcatuck	•	○			•	○				
REGION AS A WHOLE										

CHAPTER 2 THE SETTING

The Pawtuxet planning area consists generally of the area which drains into the Pawtuxet River in central Rhode Island. The area covers some 180,000 acres of land and water (about 280 square miles). Seven Rhode Island cities and towns are located in this planning area:

Coventry	Foster	West Greenwich
Cranston	Johnston	West Warwick
	Scituate	

Although it borders the lower Pawtuxet, Warwick has been included in the Narragansett Bay planning area because of that city's long shoreline along the Bay. However, flooding problems in Warwick along the Pawtuxet River are included in Chapter 8 of this report.

The Pawtuxet River and its two major tributaries, the North and South branches, form Rhode Island's second largest watershed. The total length of these three streams is 26.7 miles. Both tributaries meander through hilly western uplands to their confluence in West Warwick. Here the mainstem of the Pawtuxet continues the easterly flow to Pawtuxet Cove on the west side of the Providence River. Two other major tributaries to the Pawtuxet are Meshanticut Brook and the Pocasset River which drain most of the Johnston and Cranston area. The Big River, in West Greenwich, flows into the Flat River Reservoir (in Coventry) which becomes the South Branch of the Pawtuxet River. The Scituate Reservoir, which is the source of the North Branch, is a major Rhode Island water supply source.

The Pawtuxet basin contains the largest number of lakes and ponds (80 major water bodies) of any basin in Rhode Island. Sand and gravel deposits are found throughout the planning area. The area has a relatively small share of wetlands, the majority of which are located in the upper half of the watershed where ground water is the major source of supply. Extensive development in the downstream portion of the basin has also occurred on flood plains, making that area susceptible to flooding.

The basin has a very small coastal area with only 1.5 miles of shoreline located on Pawtuxet Cove in Cranston and Warwick. Man-made structures, such as bulkheads and rock revetments make up almost one-half of this short coastline. What there is of the natural shoreline consists mainly of bedrock outcrops. A tidal marsh and short stretches of mudflats and sandy areas comprise the remaining natural coastal features.

In this maritime climate, precipitation is high, averaging 43

inches, rather evenly distributed throughout the year. About half of this rainfall evaporates or transpires to the atmosphere through vegetation. The remaining half flows through the area's rivers and streams either directly as overland runoff, or indirectly as ground water seepage.

As of 1970, the population of this planning area was 154,000, an 18 percent increase from the 1960 level of 130,000. While this is a growth rate less than that for the Narragansett Bay and Pawcatuck areas, it is still over twice that of the region as a whole. Population is expected to increase sharply in the future — by 48 percent to 228,000 by 1990 and by a total of 106 percent or to 318,000 by 2020. These rates are the third highest in the region and the highest in Rhode Island. Most of the growth in the decade of the sixties occurred in Cranston, Coventry, West Warwick, and Johnston.

Per capita income in 1969 for the Providence-Pawtucket-Warwick area was just over \$3500. This figure is just over the national average, but some 5 percent below the SENE average. The 1970 work force of nearly 31,000 represents less than 2 percent of the workers in the region. Over one third were in manufacturing, with the retail and government sectors accounting for another one-third. During the 1960's some 4300 new jobs were added, over half of which were in the retail trades sector. Almost all the rest of the new jobs were in the finance, other services, and government sectors. Manufacturing remained stable at 12,000 jobs.

Early in the Study, workshop participants voiced a preference for reducing water consumption through higher costs for water and wastewater treatment, balancing cost shares for municipalities using the same treatment plants, strengthening the administration of existing wetlands laws, and clarifying appropriate funding shares required for acquiring and developing recreation lands. Attendees also expressed concern about increased population in the area as a result of Big River Reservoir development.

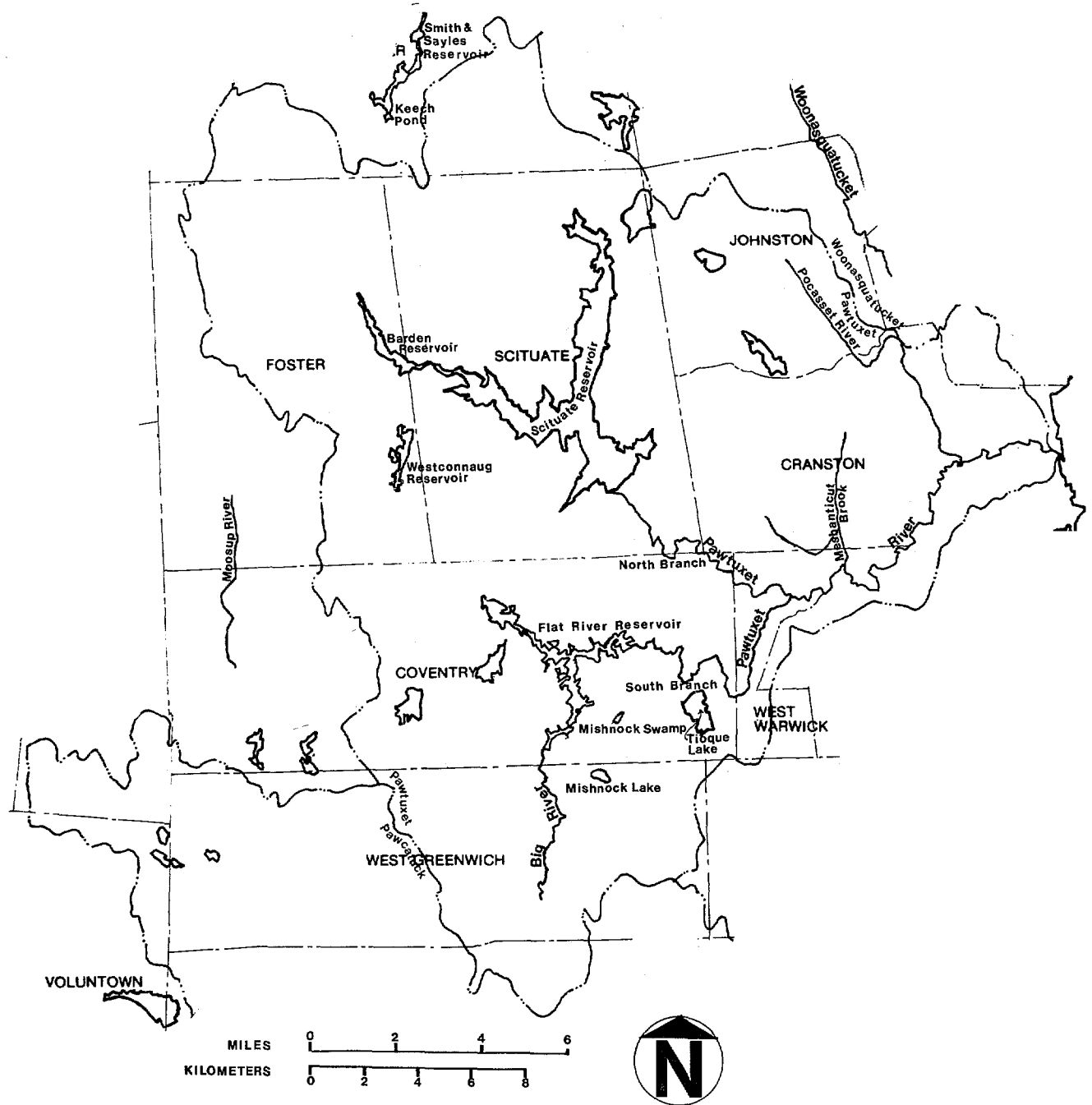
Later, during the 90-day review period, over 275 Rhode Island state, regional, and municipal officials, federal agencies, and concerned citizens submitted letters commenting on the Study's draft reports. The major comments are summarized in a Regional Report chapter, "*Review of the Report.*"

At least two major changes were made in the Pawtuxet Planning Area Report. In response to comments from West Warwick and Coventry municipal officials, *Chapter 5* now recommends evaluating three options for treating wastewater problems in the West Warwick area, rather than simply ex-

panding the West Warwick facility. In response to comments from state health officials and local water authorities, *Chapter 6* recommends strong precautions in permitting low-intensity recreation on storage reservoir lands, only on a case-by-case basis.

Several implications stand out from the preceding profile:

- (1) The combination of topography, relatively few wetlands, and development in the flood plain make the downstream part of this planning area particularly susceptible to flooding.
- (2) A relatively high proportion of the work force is still employed in manufacturing firms, many of whose process discharges will make cleaning up the river economically unfeasible in the foreseeable future.
- (3) Extensive water resources make the region a supplier to water-short Rhode Island planning areas.
- (4) Mining of the area's extensive sand and gravel reserves may be preempted by expected growth.



NEW ENGLAND RIVER BASINS COMMISSION
BOSTON, MASSACHUSETTS



SOUTHEASTERN NEW ENGLAND
WATER AND RELATED LAND RESOURCES STUDY

TOWNS AND RIVERS
IN THE PLANNING AREA

FIG.
NO.
2.1

CHAPTER 3 GUIDING GROWTH

Between 1960 and 1970, urbanized lands in the Pawtuxet area increased from 9,000 to 22,000 acres, an increase of over 125 percent. This is nearly three times the average rate for Southeastern New England. At the same time, some 40 percent of the area's agricultural lands were lost, while forested and unurbanized lands remained at roughly the same level (about 75 percent of the planning area).

This shift away from agricultural to urban uses was accomplished by an 18 percent increase in population from 130,000 to 154,000 people, and an increase in average density of .7 to .9 persons per acre. While this density is less than the region as a whole, it represents an increase in density at a faster rate than for the region. And since it represents an average for the planning area as a whole, it also belies the much higher growth and extent of urbanized land in the eastern portion of the basin, and relatively undeveloped areas in Foster, Scituate, and western portions of Coventry in the western portion of the basin. The Study's projections indicate a population increase to 228,000 by 1990, and to 318,000 by 2020, or double the 1970 population. This increase represents a growth rate of twice that of the region as a whole.

There is an increasing concern among the planning area's residents about finding ways to locate new development where it will lessen the impact on the area's land and water resources. *Chapter 2 of the Regional Report* has shown that enhancing the environment enhances the region's economy. The Study has concluded that if certain planning steps are taken, anticipated growth in the region can be accommodated while protecting the region's fragile resources. This chapter describes the nature of the growth that is expected in the Pawtuxet planning area and the ability of the resources to accommodate new development. It concludes with strategies

recommended to guide growth which are sensitive to both economic and environmental considerations.

The Situation

Anticipated Growth

As previously mentioned, the population of the Pawtuxet planning area is expected to grow to 228,000 by 1990 (a 48 percent increase from 1970), and to 318,000 by 2020 (a 106 percent increase). Assuming that the 1960-1970 rate of land consumption will apply to these population increases (5 acres consumed per additional person), over 40,000 additional acres will be needed to accommodate the additional population by 1990, and a total of 88,800 additional acres by 2020. This puts the Pawtuxet planning area in the same position as the Narragansett Bay area: there is enough land to accommodate growth to 1990, but not enough by 2020 if new development continues to consume land at the rate it did in the 1960's in the planning area.

The rates at which the various Pawtuxet area cities and towns will grow will depend to an important extent on relative development pressures. Development pressure represents a classification system using several factors which make a town attractive for growth such as existing residential, commercial, and other uses, the relative accessibility of the area to employment and population centers in other parts of the region, and the amount of easily developable land. The process for grouping the cities and towns by development pressure is described in *Chapter 3 of the Regional Report*. While other more detailed factors which the Study did not include could change the results, the combination of factors the Study did consider does give some useful indication of the pressure for development for Pawtuxet cities and towns relative to all SENE communities (see Table 3.1).

TABLE 3.1 MUNICIPALITY BY DEVELOPMENT PRESSURE: PAWTUXET PLANNING AREA

High	Medium-High	Medium-Low	Low
Johnston	Coventry Scituate	Cranston Foster West Greenwich West Warwick	none

Note: Communities are grouped into levels of development pressure relative to other communities in the Study region and do not necessarily reflect local building activity.

Accommodating Growth

It is expected that almost all of the expected growth in the next 20 to 50 years will tend to occur on land not yet developed. As of 1970, some 22,000 acres, or 12 percent of the planning area was in urban uses, up from 7.5 percent in 1960. Of the 1970 amount, 5,000 acres were in medium-intensity residential use of $\frac{1}{2}$ to 1 acre, and another 4,000 acres were in low-intensity use of over 1 acre per unit.

This means that 13,000 acres are in high-intensity urban uses such as commercial, residential of multi- and single-family units on less than $\frac{1}{2}$ acre lots, public institutions, industrial, and transportation.

Forested, open, agricultural, and water uses account for the 88 percent of the Pawtuxet area not yet developed. In order to assess the implications of growth for these resources, the Study has identified and quantified them. Classified according to development capability, these resources are grouped into three major categories as shown in Table 3.2, and mapped on Plate 3. Two of these categories represent Critical Environmental Areas: Priority Protection (Category A) and Other Protection (Category B). The first category includes water bodies, wetlands, well-sites and beaches. Insensitive use of these critical resources can constitute a threat to public health, safety, and welfare. Category B resources include those whose development

TABLE 3.2 THE SENE RESOURCE DEVELOPMENT CAPABILITY SYSTEM

CRITICAL ENVIRONMENTAL AREAS REQUIRING PROTECTION

Water Bodies (Category A), blue. [Includes estuaries, shellfish flats, and fish spawning areas.]

Priority Protection Areas (Category A), dark green: wetlands, well sites, beaches, and critical coastal erosion areas.

Other Protection Areas (Category B), light green: flood plains, class I and II agricultural soils, unique natural and cultural sites, [proposed reservoir sites and related watersheds, and upland erosion areas] excluding all "A" areas.

DEVELOPABLE AREAS REQUIRING MANAGEMENT, Excluding All A & B Areas

WATER RESOURCE LIMITATIONS

Aquifers and/or Recharge Areas (Category C₁) black dots: highest yield aquifers in each basin.

WILDLIFE AND SCENIC RESOURCE LIMITATIONS

Wildlife Habitat (Category C₃), black diagonal lines: best upland wildlife habitat other than publicly owned land and [commercial fishing grounds].

Landscape Quality Areas (Category C₂), black vertical lines: land characterized by high landscape quality other than categories C₁ and C₃.

SOILS RESOURCE LIMITATIONS

Ledge and/or Steep Slope (Category C₅), brown: land with slope greater than 15 percent and/or with rock near the surface.

Severe Septic System Limitations (Category C₄), orange: land with severe septic system limitations other than Category C₅.

Moderate to No Septic System Limitations (Categories F and G), yellow: land with moderate or no septic system limitations.

PREEMPTED USE AREAS

Urban Areas (Category E), gray: residential^{5/}, institutional, commercial and industrial development.

Publicly Owned Lands (Category D), beige: major public parks, forests, watersheds, and military lands.

Notes:

- ^{1/} All categories above, except those within brackets, are depicted on the development capabilities maps (plates 1, 2, 3).
- ^{2/} Categories in brackets are included to show where they would fit in the overall classification hierarchy, were they included on the plates in the pocket.
- ^{3/} All categories above, including those within brackets, are depicted on large-scale, unpublished maps available for inspection as part of the SENE Files.
- ^{4/} Categories C₁, C₂ and C₃ overlap with categories C₄, C₅, F, or G. Thus, Category C₃-C₄ is a wildlife habitat located on ledge or steep slopes.
- ^{5/} Mapped urban areas (Category E) include all-residential development, although the legend on Plates 1, 2, and 3 reads "residential areas on less than one acre lots."

will result in significant environmental, economic, and social costs. These somewhat less fragile resources are flood plains, prime agricultural soils, unique natural and cultural sites, upland erosion areas, and proposed reservoir sites and related watersheds. On Category C, F, and G resources — high yield aquifers, recharge areas, wildlife habitats, landscape quality areas, ledge and/or steep slopes, and soils with severe or moderate septic limitations — some development is compatible if it is carefully carried out so as not to damage intrinsic qualities and these lands are called **Developable Areas**. Existing development (Category E) and publicly owned lands (Category D) has for the most part preempted additional use. But it is worth noting that developed areas can be used — and further, that use and reuse of such land can be highly efficient. These lands and water resources of the Pawtuxet planning area have been mapped on Plate 3; the percent of the planning area in each category is displayed on Table 3.3.

As mentioned earlier in this chapter, about 12 percent of the planning area has already been developed (as “urban” use). Cranston, Coventry, Johnston, and Scituate account for most of the existing urbanized land. These urbanized areas embrace an infrastructure including sewer systems which serve 60 percent (91,000) of the total planning area population. Another 29 percent of the planning area is publicly owned. Most of the publicly-owned lands are in Scituate, Coventry, and West Greenwich. These combined amounts of urbanized (Category E) and publicly owned lands (Category D) which total some 41 percent (74,000 acres) of the planning area are more than the average for the SENE region (33 percent).

Guiding Growth

Critical Environmental Areas Categories A and B comprise some 18 percent of the planning area, the smallest share of the entire SENE region and less than three-quarters of the regional average share of 31 percent.

Category A — Priority Protection Areas, cover about 11 percent of the planning area. The diversity of these resources contributes significantly to the environmental quality of the Pawtuxet area. Wetlands, for example, are still abundant in the western portions of the basin particularly in Coventry, West Greenwich, Foster, and Scituate. But downstream, few wetlands remain in Cranston and West Warwick, *Chapters 6 and 8 of this and the Regional Report* discuss the value of wetlands for flood storage, water supply regulation, plant and wildlife habitat, water quality, and other purposes.

Another 7 percent of the planning area is covered by **Category B — Other Protection Areas** not already included in Category A resources. The planning area has relatively few flood plains (some 16,000 acres). Development in some of these flood plains, especially along the mainstem of the Pawtuxet River, has aggravated flooding and storm damage problems. Of the 2,200 acres along the mainstem, some 60 percent have been developed (*see Chapter 8, Flooding and Erosion*).

Prime agricultural lands are few in this planning area, and are prime targets for development. Nearly 43 percent of

TABLE 3.3 PERCENT OF LAND AND WATER RESOURCE CATEGORIES IN EACH PLANNING AREA

Planning Area	Total (in 1000's of acres)	Percent (%) of Planning Area				
		Critical Environmental Areas			Develop- able Areas	Preempted Use Areas
		A	B	A & B	C, F, G	D, E
Ipswich-North Shore	274	19	13	32	34	34
Boston Metropolitan	421	14	9	23	30	47
South Shore	172	17	13	30	43	27
Cape Cod & Islands	378	10	23	33	32	35
Buzzards Bay	205	17	16	33	47	20
Taunton	351	19	22	41	37	22
Blackstone & Vicinity	410	10	11	21	38	41
Pawtuxet	180	11	7	18	41	41
Narragansett Bay	212	16	16	32	34	34
Pawcatuck	262	27	12	39	40	21
SENE	2,865	16%	15%	31%	36%	33%

Sources: See Methodology in the Regional Report.

the area's agricultural lands were lost between 1960 and 1970. Over 1000 acres were lost each in Coventry, Cranston, and Johnston. The planning area has relatively few unique natural and cultural sites, with more in the western portion of the area). Development on slopes of over 15 percent causes risk of erosion and septic system seepage to areas below. Areas which are predominantly ledge — either exposed or within three feet of the surface — offer little development potential despite their physical attractiveness and aesthetic quality. Density of development on soils with severe septic tank limitations (an estimated 7000 acres in the planning area) must be regulated according to the availability of sewers.

Developable Areas — Categories C, F, and G make up some 41 percent of the planning area. Areas classified as having high landscape quality (defined by land use diversity and relief) are particularly prevalent in the central portion of the area). Development on slopes of over 15 percent causes risk of erosion and septic system seepage to areas below. Areas which are predominantly ledge — either exposed or within three feet of the surface — offer little development potential despite their physical attractiveness and aesthetic quality. Density of development on soils with severe septic tank limitations (an estimated 7000 acres in the planning area) must be regulated according to the availability of sewers.

Sewer service being proposed for the planning area would serve an additional 128,000 people. But 36,000 more people already needed service as of 1970. This leaves 92,000 in additional capacity that can be applied to new population growth. Severe septic tank limitations on some developable lands will mean those areas will have to be sewered or developed at very low densities.

The question is, how much of the expected increase in population can be accommodated on this portion of undeveloped land in the planning area. During the 1960's the land consumption rate for the Pawtuxet area was about 0.54 acre for each additional person, just above the regional average of 0.5 acre per additional person. Assuming that the same rate of land consumption will hold for the future, over 136,000 additional people could be accommodated on the planning area's C, F, and G lands. This is more than the expected increase of 74,000 people by 1990, but less than the total of 164,000 additional people from 1990 to 2020. Even if the land consumption rate were closer to the regional average of 0.5 acres per additional person, the planning area could still absorb only 148,000 additional people on lands that do not include critical A and B resources, less than the increase expected by 2020.

In addition to land use decisions resulting from the need to accommodate population growth, the planning area faces several decisions about siting large scale facilities and other development vital to the economic growth and service needs of the planning area. These developments have significant impact on land and water resources by conflicting with Critical Environmental Areas or competing with other uses for developable land. The demand for power is steadily growing but no

sites exist that are free from environmental and safety siting problems.

Sand and gravel deposits are extensive, particularly in Coventry and West Greenwich. But frequently the best sand and gravel sites are aquifer recharge areas, and care must be exercised to prevent pollution or depletion of the ground water. These factors are discussed further in *Locating Key Facilities, Chapter 9 of the Regional Report*. Similar considerations apply to solid waste disposal, large scale development, and transportation proposals such as new highways or widening of existing ones.

There is an opportunity — in fact, a need — in the Pawtuxet planning area to accommodate growth without significantly changing the water and land resources which are major contributors to the planning area's environmental quality. Decision-makers at all levels — federal, state, local, and private — can contribute to meeting this aim.

The Solutions

To take advantage of the opportunity to accommodate growth without significantly changing the area's overall environmental quality, the following program is recommended: (a) Protect Critical Environmental Category A resources; (b) Restrict development on Critical Environmental Category B resources; (c) manage development on Developable Categories C, F, and G, guiding growth to existing infrastructure.

A number of channels are available for protecting fragile resources such as existing legislation, local building codes, subdivision regulations, outright purchase. Within the context of existing channels the SENE Study recommends:

- 1. Protect priority Critical Environmental Areas. Municipalities should prohibit development on Category A Critical Environmental Areas (Priority Protection Areas). The appropriate uses of these resources include: water supply, fisheries production, limited recreation, or as scenic and open space lands.**

Category A resources are shown on Table 3.2. Planning and zoning boards should protect **water bodies** from pollution by restricting adjacent development and by controlling urban runoff through subdivision regulations requiring stormwater detention ponds and monitoring programs. Recommendations in *Chapter 5 of this report* will also help to achieve the state's water quality standards. **Wetlands** should be protected through more rigorous enforcement of the existing legislation at a local level. (*Chapter 8 of the Regional Report details how the legislation can be*

improved; Chapter 6 of the Regional Report discusses kinds of assistance available to municipalities.) Municipalities, using such programs as the Green Acres Program, and private interests, should acquire the most valuable wildlife wetlands and surrounding uplands which are mentioned in Chapter 6 of this report.

The tools for managing Other Protection Areas (Category B) are often similar to those applicable to A resources.

2. **Restrict development on Other Critical Environmental Areas.** Municipalities should restrict development on Category B Critical Environmental Areas (Other Protection Areas). Suitable uses to be considered for this category should include: agriculture, extensive recreation, forestry, or, in some cases and with proper management, very low density residential use.

Land and water resources in Category B are shown on Table 3.2. Measures for protecting flood plains described more fully in Chapter 8 of the Regional Report, include local flood plain zoning prohibiting development, discouraging or prohibiting reconstruction after substantial storm damages, relocation or floodproofing if structural protection is not available or practical. **Prime agricultural land** should be protected at the state level by tax incentives, agricultural districts, and acquisition of development rights for the highest priority lands, and at the local level by methods such as transfer of development rights. (See the Regional Report, Chapter 3, for further discussion.) **Proposed reservoir sites and unique natural and cultural sites** should be protected by acquisition of fee simple, easement, or development rights. **Upland erosion areas** should be protected by local sediment and erosion control ordinances (see Chapter 8).

The nearly 74,000 acres of Developable Areas (Category C, F, and G resources) require management to retain the intrinsic natural functions which these resources perform. The SENE Study recommends:

3. **Manage growth on Developable Areas.** Municipalities should manage growth on Category C resources and encourage growth on Category F and G resources, especially where infrastructure exists or is planned.

It is worth noting that this recommendation deals with management of all developable areas, both within existing developed areas, and in areas yet to be developed. There are no developable areas in which management of some kind is not required. On **ground water recharge areas**, housing densities should be restricted so that septic systems will not endanger ground water quality. In areas with



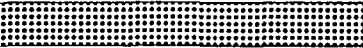
sewers and where it is economically feasible, mechanisms for recharging aquifers should be implemented. (see Chapter 4, *Water Supply*, and Chapter 5, *Water Quality*.) Other ordinances and building codes should control construction of impermeable surfaces, require stormwater retention ponds with recharge from roofs, streets, parking lots, and driveways. Regulations and sound engineering practices should be used to minimize the effects of activities hazardous to ground water such as sanitary landfill, highway deicing salt storage, industrial wastes, agricultural runoff, and sand and gravel mining below the water table. On areas with **high landscape quality, best upland wildlife habitat**, and unsewered soils with **severe septic system limitations**, only development at very low density or in clusters should be allowed. Development that would tend to preempt the resource value of wildlife habitat and landscape quality should be carefully evaluated to ensure that adverse impacts are fully taken into account. **Steep slopes** should be protected from erosion by low density use. Development on **moderate limitation areas** should be regulated to correspond to the availability of sewers. Higher densities should be encouraged on F and G lands as many C lands can support only very low densities. Such growth should take advantage of existing infrastructure wherever possible. For details about development guidelines, refer to Table 3.4.

The SENE Study findings represent a strong beginning for implementing the strategy called for in the three recommendations set out above. The information of the Study's Development Capabilities Maps is too generalized to be useful at the site design level of detail. But municipalities can use the resources information to set priorities for action. As an immediate step, municipalities can concentrate on applying SENE Study findings and recommendations into existing ordinances and building codes using more detailed maps and data. This is particularly important for cities and towns subject to high and medium-high development pressure. Further details on suggested methods for resources protection and management are discussed in Chapter 3 of the Regional Report.

Although many local governments have the authority and capabilities to implement the concept of guiding growth based on resources capability, its implementation will be most effective if adopted as a matter of state policy. This is not only because the resources extend across town boundaries, but also because additional resources (money) and expertise (information) exist at the state level.

The most expeditious way for the states to implement these concepts would be for their interagency policy councils to review and adopt as appropriate the policy issues suggested herein. Rhode Island has taken a major step in this direction by putting together a comprehensive land use plan. The SENE Study recommends:

TABLE 3.4 SUGGESTED* GUIDELINES FOR USE OF DEVELOPABLE AREAS SHOWN ON PLATES 1, 2, and 3

MAP COLOR	MAP PATTERN	NONE (color only)			
	Other Resource Limitations Soils Limitations	No other Resource Limitations	High Landscape Quality (Category C ₂)	Upland Wildlife Habitat (Category C ₃)	Aquifer and/or Ground water recharge areas (Category C ₁)
YELLOW	Moderate to No Limitations for septic system disposal (Category F & G)	- PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At least 1/2 ac/DU	If clustered on no more than 50% of area - - PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At least 1/2 ac/DU Unclustered - . Low Intensity I/C . At least 1.0 ac/DU	If clustered on no more than 30% of area - - PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At least 1/2 ac/DU Unclustered - . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 20% of area - - PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At Least 1/2 ac/DU Unclustered - . Med. Intensity I/C . At least 1/2 ac/DU Unclustered or no PW & PS - . No I/C . At least 3 ac/DU**
ORANGE	Severe septic system limitations caused by conditions other than slope and ledge soils (Category C ₄)	- PW & PS . Any I/C . Any Res. - PW only . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 50% of area - - PW & PS . Any I/C . Any Res. Unclustered or PW only - . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 30% of area - - PW & PS . Any I/C . Any Res. Unclustered or PW only - . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 20% of area - - PW & PS . Any I/C . Any Res. - PS only . Med. Intensity I/C . At least 1/2 ac/DU - PW only . No I/C . At least 3 ac/DU
BROWN	Ledge and/or steep slope greater than 15% (Category C ₅)	- PW & PS . No I/C . At least 1/2 ac/DU *** - PW only . No I/C . At least 2 ac/DU	. No I/C . At least 3 ac/DU	. No I/C . At least 3 ac/DU	. No I/C . At least 3 ac/DU .

* These are designed to provide a framework for designing guidelines of increasing specificity by state, regional, and local planners, and consultants more intimately knowledgeable with local circumstances.

** In many cases suggested guidelines for development, particularly for ground water, are estimates of probable safe controls made in the absence of greater knowledge of the effects of development on the pollution of aquifers.

*** Erosion control measures should accompany other restrictions on slopes over 15%.

Med. & Low Intensity - refers to water use/effluent discharge/building coverage

Clustering - refers to percent impermeable land surface area which may adversely effect the resource.

PW - Public Water Supply System

Res. - Residential

PS - Public Sewer System

ac - acre

I/C - Industry/Commercial

DU - Dwelling Unit

4. Use SENE Study resource development capability analysis to guide future growth. The Rhode Island Statewide Planning Program and State Planning Council should incorporate the SENE Study resource classification system into the land use plan. Guidelines can be developed at state and local levels of government. State agencies should provide technical assistance to local governments in applying guidelines at the local level. *Chapter 10 of the SENE Regional Report describes several options for developing these guidelines.*

Chapter 3 in the Regional Report describes the economic inefficiencies and environmental costs of urban sprawl. Making better use of roads, sewer systems, and water supply systems where they already exist could help to avert those costs. Therefore, it is recommended to:

5. Accommodate growth where services already exist. The Rhode Island State Planning Council, in concert with towns and state agencies, should implement policies to accommodate further development in already developed areas, and to permit maximum use of existing water, sewer, and transportation service. Planned unit development and the cluster principle should also be encouraged in these areas.

The Regional Report also recommends establishing a system for determining criteria for locating developments of regional impact. This would be within the framework of the system designed to protect Critical Environmental Areas and manage Developable Areas and would enable consideration of environmental and economic implications of siting decisions. Power plant siting problems in this planning area would be under its jurisdiction. *Details of this recommendation can be found in the Locating Key Facilities chapters of this and the Regional Report, and Chapters 3 and 10 in the Regional Report.* Consistent with siting criteria suggested for other facilities of regional impact, highway planners and state officials should give special consideration to avoid Critical Environmental Areas (Categories A and B) and using limited Developable Areas (Categories C, F, and G) consistent with other needs for those same lands.

Priorities

Municipalities which should act especially promptly to carry out the recommended actions are those with high and medium-high development pressure (Table 3.1): Johnston, Coventry, and Scituate. Wetlands, prime agricultural lands, and flood plains in these municipalities should be given immediate attention for protection. Johnston, especially, should act promptly to preserve unique natural areas and agricultural lands.

Implications

The impact of these recommendations on development patterns in the planning area, considering the amounts and types of land and the projected population, should be significant. Application of SENE Study recommendations throughout the Pawtuxet planning area can make an important difference in trying to prevent degradation of the region's remaining fragile natural areas.

The projections show that there is not enough developable land to accommodate expected growth in the next 50 years. Over 40 percent of the entire planning area is available for development even after setting aside critical areas too fragile to accommodate development without unacceptable damages, publicly-owned areas, and already urbanized lands. But that is not enough land, assuming present rates of land consumption. This means one of three things: (1) The land consumption rate is going to have to change, by increasing densities on some areas, while ensuring protection of others; or (2) Some of the growth will have to go to other areas (such as the Pawcatuck planning area); or (3) Some of the growth will encroach on some of the Critical Environmental Areas.

The approach recommended in this chapter emphasizes the importance of assessing the full range of environmental and economic costs which should be considered when making development decisions. Most importantly, this approach shows how we can decrease the cost of development to the taxpayer and prevent the degradation of the remaining fragile natural resources at the same time. While the SENE Study is not a comprehensive land use plan, the preceding recommendations represent the key steps that land use planners can take to guide the area's future growth.

CHAPTER 4 WATER SUPPLY

The Situation

The Pawtuxet planning area is one of the most productive water supply basins in Southeastern New England. The Scituate Reservoir complex, in this planning area, provides the Providence Water Supply Board with its total yield of 72 million gallons per day (mgd).

In 1970, the Providence system supplied an average of 13.7 mgd within the basin, providing 12.2 mgd to Cranston and 1.5 mgd to Johnston. It appears that these two municipalities will be fully served by public systems before 1990. Planned expansion of the Providence Water Supply Board should be adequate to accommodate their future needs. In addition, the northern section of Scituate, which will require public water service by 1990, would best be served by a connection to the Providence system in Johnston. Local ground water resources in Scituate do not exist in large enough quantities to adequately supply the municipality's future demands.

A high yield aquifer, with rather low quality ground water, exists in the urban area of Cranston and Providence. Though no public supplies are obtained from this source, it appears to be an acceptable source of water for industrial uses. If developed, this supply could help to reduce the total demand on the Providence system.

The remaining basin municipalities, with the exception of Foster, receive their water supply from the Kent County Water Authority's ground water resources. In 1970, this system provided an average 4.2 mgd to the eastern portion of Coventry, small sections of Scituate and West Greenwich, and West Warwick. Roughly half this amount was purchased from the Providence Water Supply Board. Water service areas in each of these municipalities will be expanding, especially in Coventry. Future demands on the Kent County system are expected to require the development of ground water resources near Mishnock Lake and the Flat River Reservoir as well as utilization of undeveloped reserves in East Greenwich (Narragansett Bay planning area), and perhaps water from the Big River Reservoir.

The Solutions

Table 4.1 displays a summary of existing safe yields or pumping capacities, estimated 1990 water demands, and proposed future sources of water supply in the planning area. The following discussion will deal with the water resources and the opportunities to meet future demands in the Pawtuxet planning area.

TABLE 4.1 SUMMARY OF 1990 WATER SUPPLY: PAWTUXET PLANNING AREA

Municipality	Existing System (1970)		1990 Average Demand mgd	1990 Design Demand ^{b/} mgd	Proposed Additional Source of Supply
	Source	Safe Yield ^{a/} mgd			
Coventry	Kent County Water Authority	1.70	3.93	7.35	Kent County Water Authority
Cranston	Providence Water Supply Board	12.15	15.31	15.31	Providence Water Supply Board
Foster	Private Wells	--	---	---	Private Wells
Johnston	Providence Water Supply Board	1.52	2.96	2.96	Providence Water Supply Board
Scituate	Kent County Water Authority	0.13	.55	1.26	Kent County Water Authority
W. Greenwich	Kent County Water Authority	0.003	.07	.19	Kent County Water Authority
W. Warwick	Kent County Water Authority	2.34	3.56	6.73	Kent County Water Authority

^{a/} Indicates amount of water furnished to the town by regional system in 1970.

^{b/} Systems relying primarily on ground water sources must supply maximum day demands.

Recommendations

Cranston and Johnston. As discussed above, these two municipalities would be best served by an extension of the Providence Water Supply Board's existing service area. A number of alternatives exist for this expansion. Of high priority in the Rhode Island plan is the development of the Big River for water supply use. Other alternative plans suggest development of the Wood River Reservoir, development of the Big River Reservoir in conjunction with flood skimming of the Flat and Moosup Rivers, and development of the Buck's Horn Brook Reservoir. Because contamination problems are likely to arise in the rivers that would be skimmed, the proposed development of the Big River Reservoir (26 mgd) is given the highest priority for development by the State. This alternative is strengthened by the fact that the necessary land area for the project has already been acquired.

It appears that development of the Wood River Reservoir can be postponed or perhaps avoided. The SENE Study's demand projections indicate that sources of the Providence system need only be expanded by 8 mgd by 1990. This means that the Wood River Reservoir will not be required for some time after that date. In addition, there are social and recreational costs involved in this project because the Wood River has been proposed for designation as a state scenic river. Moreover, a considerable amount of the planning area's forested recreation resources would be flooded by the reservoir (*Chapter 6, Outdoor Recreation*). By the time the water from the Wood River Reservoir might be needed, significant advances in technologies such as desalination *may* provide economical alternatives to the reservoir.

The water from the Big River has been classified "A", and proposed goals call for maintenance of this high quality. Rhode Island's Water Resources Board has proposed that the Big River Reservoir be constructed. The water from this reservoir will inundate the southern part of Coventry and a good deal of the town of West Greenwich. However, development of the Big River Reservoir would add a significant amount of water to supply the state of Rhode Island in general. The reservoir's 26 mgd would supply not only the urban areas in the Pawtuxet planning area, but also portions of the Woonasquatucket basin and the Upper Narragansett Bay area. Accordingly:

1. **Petition the General Assembly to approve construction of the Big River Reservoir.** The Water Resources Board should petition the General Assembly to approve construction of the Big River Reservoir. The administration of this supply, either through the Providence Water Supply Board or the Water Resources Board, should assure multi-purpose use of the proposed diversion sites on the Wood River and should assure the use of the

ground water resources of the Wood River Valley. This will minimize costs of water supply and will postpone for as long as possible any surface water impoundments of the Wood River.

A third form of administration suggested during the 90-day review period is a metropolitan water authority composed of representatives from cities and towns in the metropolitan service area.

Additional discussion of the Big River Reservoir proposal may be found in the Blackstone and Vicinity Planning Area Report.

A ground water reservoir is located in the municipalities of Cranston and Providence, just west of the Providence River. The aquifers are formed of unconsolidated glacial outwash and underlying bedrock. Although no public supplies are obtained from this resource, in 1970, an average of 2.27 mgd was withdrawn for cooling by the Falstaff Brewing Company. The Cranston-Providence aquifer receives its inflow from direct infiltration by precipitation. Intense urbanization directly above the recharge area has increased surface runoff and decreased infiltration to the ground water reservoir. Moreover, urban flooding and increased stress on wastewater treatment facilities have caused pollution of these aquifers. Other potential sources of pollution are liquid wastes, solid waste leachates, and spillage and leakage of liquids such as gasoline and fuel oil.

Ground water from the Cranston-Providence area is generally more mineralized than ground water in the upper parts of the basin. It is moderately hard and has chloride concentrations generally greater than 20 milligrams per liter (mg/l). Iron is present in objectionable quantities in nearly all water from bedrock wells and in about half the water from wells tapping outwash deposits. It is unlikely that public supply wells will be developed here. However, the Cranston-Providence aquifer may be a prime source of water for the industries of West Warwick, Cranston, and Johnston.

Although ground water from this aquifer supplements the flow in the lower reaches of the Pawtuxet, Woonasquatucket, and Providence Rivers, withdrawals are not expected to have significant effects on streamflows and pond levels. Therefore, management of ground water recharge through the use of special structures such as basins and wells can be an important technique to be applied in this urbanized area. Alternative in- or on-ground disposal of storm runoff should be considered during any further reconstruction in the planning area.

In addition to urban pollution, degradation of ground water quality from natural sources also takes place in the

Cranston-Providence area. Excessive withdrawal from the shallow sand and gravel aquifer could cause salt water in the Providence River to move laterally into the aquifer and its wells. Numerous wells near the shore of the Providence River yield brackish water, particularly when pumping rates are highest. Salt water from the Providence River can be expected to intrude into the bedrock and unconsolidated aquifers when water levels in the aquifers near the Bay are drawn down below sea level. For example, wells near Sassafrass Point have had drawdowns as great as 28 feet below sea level, and well water has contained chloride concentrations as high as 8000 mg/l. Although increased industrial use will probably be favored for development of this aquifer, deterioration of water quality is likely, due to contamination of recharge, as well as overpumping. Careful management of the ground water resource through the use of permits for withdrawal can minimize this deterioration. The SENE Study makes the following recommendations:

2. Protect the aquifer underlying Cranston and Providence for industrial water supply.

The aquifer underlying the urban area of Cranston and Providence should be managed in order to maintain its usefulness as an industrial water supply, thereby reducing local industry's reliance on the Providence system.

3. Expand Providence Water Supply Board to serve northern Scituate. The Providence system, through Johnston, should be expanded in order to meet increased demands from northern Scituate.

Towns Dependent on the Kent County Water Authority. The 1970 pumping capacity of the Kent County ground water system, both within the basin and in the adjacent Narragansett Bay planning area, was 9.8 mgd. The estimated 1990 maximum day demand on the entire system is about 19.4 mgd. New resources will have to be developed to meet these additional needs.

The drainage area of the South Branch of the Pawtuxet River contains the second significant ground water source in the Pawtuxet basin. The aquifer which lies between Flat River Reservoir, Tiogue Lake, and Mishnock Lake is over 100 feet thick in places where glacial outwash fills bedrock channels. South of this area, in the vicinity of the proposed Big River Reservoir, outwash is generally less than 50 feet thick and is only partly saturated with water. The present pumping capacity in the Mishnock-Tiogue Lake area is about 3 mgd. Wells pumping ground water from this aquifer are a primary source of water to the Kent County Water Authority.

Within the South Branch drainage area, Mishnock Swamp in Coventry and West Greenwich is probably the most promising site for ground water exploration. Even with the Big River Reservoir in place, there is potential for additional ground water development in the Mishnock Swamp area. Although the subsurface geology of this site has not been explored, it appears likely that as much as an additional 3 mgd can be supplied from its aquifers. Ground water withdrawals from the Mishnock area would not affect the Flat River or proposed Big River Reservoirs, but would deplete the flow of the Mishnock and South Branch Pawtuxet Rivers. Pumping of wells must be controlled to avoid harmful depletion of streamflows or lowering of pond levels. This control is particularly important because of recommendations in *Chapter 6* to acquire these areas for fish and wildlife production.

Coventry, West Greenwich, West Warwick, and the southeastern portion of Scituate are projected to have a combined maximum day demand which will exceed the present pumping capacity of the Kent County system by 1990. Therefore, the Kent County system will probably be required to obtain additional ground water supplies from the areas along the South Branch of the Pawtuxet, or to depend to some degree on surface water from the proposed Big River Reservoir. Table 4.2 shows projected 1990 maximum day demands for municipalities on the Kent County

TABLE 4.2 1990 DEMANDS AND GROUND WATER RESOURCES IN MUNICIPALITIES SERVED BY THE KENT COUNTY WATER AUTHORITY

Municipality	1990 Maximum Day Demands (mgd)	Ground Water Favorability
Coventry	7.35	Unfavorable*
Scituate	1.26	Unfavorable
West Greenwich	0.19	Favorable
West Warwick	6.73	Unfavorable
East Greenwich	3.91	Favorable
Total	19.44	

*There may be as much as 6 mgd available in Coventry.

system and the favorability of meeting these demands from ground water resources within the municipalities, as determined from available data.

Though there appear to be adequate resources to supply the 1990 demands of most of the municipalities in the planning area, West Warwick and Coventry could have to modify their water consumption patterns if ground water exploration is unsuccessful. Through reduction in demand patterns through water saving devices and public education is a general recommendation of this Study, reliance on surface water sources or on the Providence system after 1990 appears inevitable. Therefore the SENE Study recommendations are as follows:

4. **Develop ground water reservoir in Coventry and West Greenwich to serve Kent County system municipalities. The Kent County Water Authority, in conjunction with the Water Resources Board should develop a ground water reservoir in Coventry and West Greenwich to serve additional demands in West Warwick, Coventry, West Greenwich, and southern Scituate.**
5. **Limit water use or supplement supplies from surface sources in Coventry and West Warwick. Limitations on water consumption may be required before 1990, should ground water investigations in Coven-**

try and West Warwick reveal insufficient resources to meet projected demands on the entire Kent County water system. These towns should also investigate the feasibility of supplementing existing supplies from the Providence Water Supply Board's Scituate Reservoir complex or from the proposed Big River Reservoir.

The last chapter in this report, on *Locating Key Facilities*, points out that the Coventry and West Greenwich areas have significant deposits of sand and gravel. While the sections of these two towns that depend on ground water for their supplies should carefully protect their existing and proposed well sites, it may be possible to consider the Big River Reservoir site as a source of sand and gravel before construction of the reservoir. Present plans call for very little excavation of the reservoir site. However, mining of the sand and gravel reserves in this area may help to offset construction costs while providing a balanced and systematic use of the planning area's resources.

Chapter 6 discusses the potential for low-intensity recreation on lands adjacent to reservoirs. While the Scituate and Big River Reservoir watersheds could satisfy an enormous portion of demands for extensive outdoor recreation activities, the Study suggests a cautious go-ahead on the way this should be developed.

CHAPTER 5 WATER QUALITY

The Situation

Existing water quality on the Pawtuxet River, which includes the North Branch and the South Branch, ranges from Class B (water suitable for bathing and water supply with appropriate treatment) to Class E (nuisance conditions). The upper portion of the drainage basin has little development and, as a result, is nearly free of man-made pollution. Small, swift flowing streams feed the reservoir, draining the hilly, wooded terrain. The lower stretches of both branches, and especially the mainstem of the Pawtuxet, flow through highly developed areas, and receive large quantities of man-made pollution.

The North Branch begins at the outlet of the Scituate Reservoir, a water supply reservoir in the town of Scituate which is operated and owned by the city of Providence. Flow from the reservoir is regulated to meet the water needs of the city of Providence and other downstream users.

The South Branch begins at the Flat River Reservoir in Coventry and is regulated by the Quidneck Reservoir Company to meet the water needs of member industries downstream. Consequently, flow in the South Branch drops considerably on the weekends when these firms are closed and the downstream water requirements are low. In addition to the two reservoir dams at the headwaters and the Pawtuxet Cove dam at the river's mouth, river flow is impeded by at least 19 mill dams along both branches and the mainstem.

The Scituate Reservoir is Class A, while the Flat River Reservoir is Class B. Most of the length of both the North and South Branches of the Pawtuxet is Class C, suitable for fish and wildlife habitat and industrial processes. A large portion of the mainstem is classified D, with a small stretch below Ciba-Geigy (a chemical manufacturing firm) classified E.

The major determinants of the poor water quality in the

basin are municipal discharges, industrial discharges, and low stream flow. The sheer volume of these discharges to this relatively small, sluggish river is expected to result in a water quality classified no better than Class D in the lower Pawtuxet River, even with the application of advanced treatment techniques. Major out-of basin transfers of water — 72 mgd from the Scituate Reservoir complex and 26 mgd from the proposed Big River Reservoir indicate that, in the foreseeable future, the volume of wastewater in the basin will continue to increase, while the average streamflow from the upland drainage sub-basins will decrease. This is the major consideration in the argument that Class D is the highest quality which can be expected on the lower Pawtuxet River. Furthermore, access to the river there is limited by the commercial-industrial land use, so the benefits of water quality better than Class D may not be realized in any event.

Of the seven municipalities within the basin, three have wastewater treatment systems — Johnston (to Providence facility), Cranston, and West Warwick. Warwick, which has been included in the Narragansett Bay planning area but is also discussed here, also has a wastewater collection and treatment system. All of Foster and Coventry are served by individual subsurface systems.

Current Actions

A major component of the Federal Water Pollution Control Act Amendments of 1972 is the National Pollution Discharge Elimination System (NPDES), a portion of which is more commonly known as the industrial permits program. Major industrial discharges should be eliminated by connection to municipal systems, by subsurface disposal methods, by process changes, or by the closing or moving of a firm. The Pawtuxet River has been receiving smaller amounts of industrial pollutants as industries treat or tie into the three municipal secondary treatment facilities. Eleven industries have ceased process water discharges, ten by municipal connections and treatment.

TABLE 5.1 SEWER SERVICE: PAWTUXET PLANNING AREA

Sewer System	1971 Population Served	Degree of Treatment	Receiving Waters
Cranston	65,000	Secondary	Pawtuxet River
Warwick*	6,600	Secondary	Pawtuxet River
West Warwick	20,375	Secondary	Pawtuxet River

* Narragansett Bay planning area

Arkwright-Interlaken, a former industrial discharger on the North Branch, has eliminated its direct discharge to the North Branch by providing treatment before disposal to a leaching field. American Hoechst currently has a system in operation which is designed to eventually reduce its waste load by 98 percent. Several firms on the South Branch have been connected to the West Warwick treatment facility, thereby eliminating direct industrial discharges and receiving secondary treatment for their wastewaters. Additional connections by firms on the South Branch are planned. Ciba-Geigy has constructed bio-oxidation towers to treat their wastes, but this technique has been effective in removing only 50 percent of the BOD (biochemical oxygen-demanding wastes), instead of the projected 90 percent. Treatment of this firm's wastewater is to be provided at the City of Cranston's wastewater treatment facility which is to be upgraded and expanded.

The Solutions

Recommendations

Despite these efforts, water quality is not expected to improve above Class D levels in the lower reach of the river. Attempting to achieve Class B waters would quite probably use all the funds available to the rest of the state, thereby preventing Class B in areas where it is achievable. For this reason, the Pawtuxet should have basic aesthetic and public health values attained, but a swimmable-fishable goal should not be sought in the short-term future. Nevertheless, the water quality program for the Pawtuxet planning area should stress continuation of the industrial permits program, as stated in *Chapter 5 of the Regional Report*, and, in the long-run, other efforts to upgrade water quality.

The following actions, together with recommendations in the *Water Quality chapter of the Regional Report*, represent a package of ongoing proposals supplemented by SENE Study recommendations which, if fully implemented, are designed to achieve the stated goals.

Restoration. The recommended treatment scheme for the municipalities in the planning area is:

1. **Continue with expansions of the Warwick and Cranston secondary treatment plants. Cranston will accept flows from the state institutions.**

Because of the complexity of the wastewater disposal problems in the Pawtuxet basin, an in-depth analysis is required to determine the best treatment scheme on the South Branch. Since it is not the function of the SENE Study to perform such analyses, it is recommended that the following alter-

natives be evaluated in the areawide "208" plan now being prepared by the State of Rhode Island.

2. **Evaluate treatment options in the West Warwick area.** Either (a) expand the West Warwick secondary treatment plant to serve West Warwick and portions of Coventry, West Greenwich, Scituate, and Cranston; or, (b) construct a secondary treatment plant in Coventry to serve eastern Coventry, and a portion of West Greenwich, with the West Warwick treatment plant serving West Warwick, southeastern Scituate and southwestern Cranston; or, (c) provide some combination of the above two alternatives, in which some wastewater from the northeastern section of Coventry will be transmitted to West Warwick, with the rest of Coventry's sewerage system served by a plant in Coventry.

Whether or not advanced treatment will be required for any or all of these facilities is to be determined in the areawide waste treatment management plan (208 plan) being prepared by the Rhode Island Statewide Planning Program.

Since it is usually less expensive to build and operate one large treatment facility, particularly an advanced treatment facility, the alternative of one regional plant in West Warwick would probably be the least expensive treatment scheme. This will have to be determined in the facilities plan. A regional plant in West Warwick would result in one less discharge to the river, since the Coventry treatment plant would not be constructed. Coupled with control of industrial discharges under the NPDES system, the regional plant should substantially improve the quality of the upper Pawtuxet. Upgrading to Class B would be precluded, however, by the pumping stations on the North and South Branches required by the regional plant in West Warwick. For precautionary reasons, the Rhode Island Department of Health designates waters in the vicinity of pumping stations no higher than Class C. As a result of comments from Coventry officials who feel that the West Warwick treatment facility is too distant from the town's water quality problems and from West Warwick officials who do not want the added costs of treatment, the Study has not recommended this option as the sole solution to the area's problem.

Separate treatment facilities in Coventry and West Warwick would utilize a longer stretch of the river for assimilation of wastewater, permitting the discharge of a greater volume of wastewater. This, in turn, would permit more development than a single regional plant in West Warwick.

Alternatives calling for out-of-basin discharge of all wastewaters were not recommended because of the expense and adverse environmental aspects during low

flow periods which would leave the river generally unfit for most uses and aesthetically unpleasing.

Estimated costs of the first recommendation in Cranston are \$11.5 million. For the second recommendation, preliminary cost estimates have been developed for its first alternative: Coventry — \$16.5 million, for its share of the West Warwick Plant expansion project and provision of advanced treatment; and West Warwick — \$2.5 million for its share of advanced treatment; and Cranston — \$11.5 million. West Greenwich and Scituate would share portions of Coventry's costs as they, too, would be served by the West Warwick plant, and the project will require larger interceptors.

Preservation of Existing High Quality Water. Of paramount importance in this planning area is the preservation of the existing high quality water in its upper portions.

With no discharges of treated wastewater to augment low flows, flow in the North and South Branches will become even more of an issue than it is at this time. Therefore, in order to provide adequate streamflow for recreational water use and fishery development,

3. Negotiate an optimal flow regime. Negotiations should begin as soon as possible with representatives of federal, state, and local governments and private concerns in order to determine an optimal flow regime for the North and South Branches of the Pawtuxet River.

This recommendation is essential in light of the proposed development of the Big River Reservoir. Minimum releases should be obtained so that the costs of clean-up efforts will truly reap water quality benefits. The Department of Health and the Water Resources Board should ensure that the negotiations are conducted between municipalities to improve low flows at least to the extent that this regime will be compatible with achievable downstream wastewater treatment measures and water uses.

Another threat to water quality is malfunctioning septic systems. These have resulted in the preceding proposals for sewer service and attendant treatment facilities. Rigid enforcement of existing regulations may preclude many of the problems of these systems. However, an in-depth look at the criteria for locating, siting, and designing individual subsurface disposal systems is also necessary since some aspects of existing regulations may still allow problems to develop. For example, high percolation rates coupled with the minimum allowable depth to ground water may result in bacterial contamination, nitrate build-up, or even phosphate build-up in that ground water. Also, allowing systems to be placed in fill material might invite clogging conditions at the fill-old surface interface.

Rhode Island has recently reviewed and up-dated its regulations regarding individual disposal systems and believes them to be adequate. With proper enforcement, and by restricting the use of such systems to those lands suitable for septic tanks, individual disposal systems should continue to be useful for an important portion of future residential development. Without such precautions, the cumulative failure of individual systems will intensify pressure for sewer extensions and new treatment works. The result will be new concentrations of effluent in high quality streams, loss of in-basin ground water resources, increased municipal service costs, and, inevitably, the increased density of development induced by sewer service.

Implications

Coupled with proper land use regulations, the recommended actions can help maintain the general character of the upper portions of the planning area's waters without causing environmental degradation or costly after-the-fact restoration. The responsibility for implementation of these proposals will rest primarily on local governments and affected industries, with financial aid provided to municipalities by the state and federal governments.

CHAPTER 6 OUTDOOR RECREATION

GENERAL OUTDOOR RECREATION

The Situation

The Pawtuxet planning area's water and related land resources are extremely valuable for recreation. Among the existing and potential recreational resources are 6,000 acres (3 percent of the total planning area) of publicly or semi-publicly owned land and water, including John Curran and Snake Den State Parks; 80 lakes and ponds which have minimal beach development; and about 150,000 acres of wetlands, forests, and water bodies, several thousand acres of which are protected for public water supply. The Bureau of Outdoor Recreation (BOR) estimates that the amount of publicly accessible and developed recreational resources is enough to satisfy 6 percent of the 1990 needs for swimming, 60 percent of the 1990 needs for campsites, 2 percent of the 1990 needs for picnic tables, and about a third of the 1990 needs for extensive (low-intensity) outdoor recreation. The deficiencies indicate a need to develop about 60 additional acres of beach, about 650 additional campsites, about 1,000 additional picnic tables, and about 15,000 additional acres of land for extensive outdoor recreation (informal picnicking, hiking, nature study). Needs for salt water fishing, recreational boating, and ocean beaches cannot be satisfied in this planning area, but plans to satisfy them are pursued extensively in the Regional Report.

The Solutions

Chapter 6 in the Regional Report describes two options for satisfying camping and picnicking needs and six options for satisfying extensive outdoor recreation needs. The Regional Report also describes economic, environmental, and social implications of each option. The following recommendations for supplying the Pawtuxet's recreational needs have been based on an evaluation of those options and their implications.

By the time the Big River Reservoir is developed, water authorities will own at least 10 to 20 percent of this planning area's related land resources which are near wilderness in nature. This would represent more than enough land to satisfy the 1990 demands of this and neighboring planning areas for extensive outdoor recreation, hunting, and fishing. *Chapter 6 in the Regional Report* points out that while there are no state statutes prohibiting extensive outdoor recreation on reservoir lands, there is a law holding

local water authorities legally responsible for degradation in water quality. For their own protection, trespassing on watershed lands is prohibited. However, evidence in scientific literature supports the theory that recreational use of reservoirs and related lands can have minimal impact on bacterial and viral counts, certainly within the range of best known treatment levels. Recommendation 17 in the Regional Report therefore suggests that the Department of Natural Resources, working with the Department of Health, Water Resources Board, and local water authorities, should develop guidelines and regulations for passive outdoor recreation, particularly on storage reservoirs. For the Pawtuxet planning area, the Study recommends:

1. **Develop guidelines for planning low-intensity recreation on lands adjacent to storage reservoirs.** Using guidelines prepared by the Department of Natural Resources and others, local water authorities should plan for extensive outdoor recreation, hunting, and perhaps fishing on storage reservoir watersheds.

Another kind of public property — state parks — has not been developed to its greatest recreational potential either. Therefore, an important recommendation is:

2. **Provide picnicking and extensive recreation at John Curran State Park.** The Department of Natural Resources should develop John Curran State Park, providing picnicking, possibly camping, fishing, and extensive opportunities (although at the present time no funds are available).

The popularity of biking, hiking, trail bikes, and snowmobiles has stimulated the search for paths and trails. In fact, the Pawtuxet River Authority's recent efforts to develop a trail from Route 37 to Route 5 have been thwarted by exorbitant costs of development. Rhode Island is fortunate to have a Trails Advisory Committee, composed of various trail use interest groups, the Statewide Planning Program, the Departments of Natural Resources and Transportation, plus the federal Department of Transportation. The main job of this subcommittee is to assist the director of the Department of Natural Resources in the development of a statewide trail program. The SENE Study recommends:

3. **Develop two regional trails.** The Trails Advisory Committee with the Pawtuxet River Authority should assess plans for a trail along

the abandoned railroad line from the River Point area in West Warwick to Hope and the Scituate Reservoir, and another along a power line right-of-way from the Flat River Reservoir northeast to the Pawtuxet River. They should recommend whether the state should develop the trails and suggest appropriate uses.

There are extremely attractive parcels of water related land in the planning area capable of supporting recreational demands of regional dimensions. If all the basins waters, including Scituate Reservoir, had adequate public access and were under fisheries management, they could support an estimated 400,000 man days of fishing, over 95 percent of the planning area's 1990 demand. The Study recommends the following:

4. **Acquire access to Kimball Reservoir and Stone Pond.** The municipality of Johnston should acquire access to Kimball Reservoir and Stone Pond and develop areas for swimming, picnicking, boating, and camping. Using Land and Water Conservation Funds, Johnston could fulfill proposals in the Town Plan for recreational acquisitions.
5. **Acquire several parcels at the Flat River Reservoir.** Using Land and Water Conservation Funds, Coventry should acquire several parcels of the Flat River Reservoir and develop them for swimming, picnicking, and extensive outdoor recreation activities.

Campgrounds are controversial in most towns because they strain local services and rarely contribute to local economy. These negative impacts can be minimized by controlling their development and design. *Chapter 6 of the Regional Report* recommends ways for the Department of Economic Development to expand its program of encouraging private campground developers. Along these lines, the Study recommends:

6. **Develop a statewide recreational advisory committee.** A state program to encourage private campground development (see *Chapter 6 of the Regional Report*) should identify aesthetically pleasing and scenic locations for these facilities along the Pawtuxet's abundant lakes and ponds.

Plate 3 shows the location of Critical Environmental Areas, which, as is described in *Chapter 3*, have important roles in natural processes such as riverine and coastal flooding and erosion protection, water supply, and wildlife protection. These areas require protection. They can also be used for varying degrees of recreation, particularly low-intensity.

Since protection and development of such resources is best coordinated at the local level, the SENE Study recommends:

7. **Use Development Capabilities Maps for open space protection programs.** Municipalities should plan Critical Environmental Areas identified on Development Capabilities Maps for open space protection and green-belt programs. Methods for protecting such resources without outright acquisition are described in *Chapter 3 of the Regional Report*.

Implications

According to the Bureau of Outdoor Recreation these recommendations (excluding public access to reservoirs and private campground development) could potentially add almost 60 acres of fresh water swimming resources, thereby meeting almost all the 1990 demands for swimming; 93 acres for picnicking which, with the existing areas, would meet about 45 percent of the 1990 needs; 50 acres for camping which, with the existing campsites, would meet about 80 percent of the 1990 needs; and about 6,700 acres of natural areas which, with the existing resources, would meet over half the 1990 demands for nature study and hiking. To reiterate an earlier point, public access to reservoir lands would satisfy fully 100 percent of the 1990 demands for extensive outdoor recreation.

The program for satisfying future recreational needs of the Pawtuxet planning area was derived from two possible approaches. One approach would stress the most cost efficient recommendations, usually intensifying the use of existing facilities, even with the possibility of diminishing the quality experience and large new acquisitions at any cost.

Recommendations which make the most recreational use of lands already publicly owned received the highest priority. In this regard, permitting extensive recreational activities on water supply reservoirs has particularly high returns for social well-being and for cost efficiency in recreational planning. New acquisitions (trails and ponds) are important for meeting future recreational demands.

WILDLIFE AND FRESH WATER FISHERIES

The Situation

Most of the Pawtuxet planning area is fairly open — over 88 percent of the area is either forest, agricultural, wetlands, or open water. Over 78 percent of the forest land is rated as fair wildlife habitat and 42 percent of the planning

area's wildlife habitat is open to hunting. Some 11,400 acres are publicly owned and open to public hunting. Another 50,200 acres are privately owned and open to hunting. This total would meet 55 percent of the 1990 in-basin demands for hunting in the planning area. Posting to trespass is becoming increasingly common.

Public access to fresh water resources is an obstacle to meeting planning area demands for fisheries. There are currently enough available fresh water fisheries to meet 15 percent of the total 1990 demands. The Division of Fish and Wildlife has undertaken an active program of acquiring public access to the several hundred ponds and nearly one hundred miles of streams in the planning area, but agrees that more is needed.

Finally, due to the close proximity of the Pawtuxet basin to the Providence metropolitan area, much of the largely unmet hunting demands of the metropolitan area will be diverted to this planning area.

The Solutions

Chapter 6 of the Regional Report describes four options for satisfying the planning area's future demands for wildlife and two options for future fishing demands and their implications. The following recommendations are based on an evaluation of those options.

Due to wetlands' multiple benefits of flood reduction, water supply regulation, and wildlife production, the Study has recommended protection of them to the maximum extent. This can be done without impairment to economic growth (*see Chapters 2 and 3 of the Regional Report*). The Rhode Island Freshwater, Intertidal, and Saltwater Wetlands Protection Laws give municipalities a substantial amount of authority in deciding whether or not alteration of wetlands should be permitted, but often their efforts are frustrated by inadequate knowledge or expertise. Because cumulatively, municipalities can protect significant amounts of wetlands through legislative channels, the Study encourages their responsibilities with this recommendation:

8. **Improve enforcement of existing wetlands legislation.** The Rhode Island Department of Natural Resources should provide additional technical and legal assistance to local officials to improve enforcement of existing wetlands legislation.

Outright acquisition is the safest assurance that wildlife habitats will be protected, and the state's responsibility should be to purchase those areas of regional significance (*Chapter 6, Regional Report*). However, smaller wetlands and adjacent or surrounding uplands are often the most

productive ones, and frequently towns prefer to control them. Hence, the following recommendation:

9. **Acquire the most important wildlife habitats.** Municipalities and/or private organizations should consider acquiring significant wetlands and upland habitats which are most important for wildlife production identified in *SENE Study single-purpose inventory available in the NERBC files* throughout the Pawtuxet planning area. The most important of these are:

West Greenwich: Cedar Swamp, Nooseneck, Raccoon, Cong- den Rivers	Foster: Hemlock Brook area
Johnston: Cedar Swamp Brook, Simmons Reservoir Swamp	Cranston: Dyer and Randall Ponds
Scituate: Quonopaug Brook Swamp	Coventry: Mishnock Swamp, Flat River Reservoir, Pawtuxet River Swamps, along Pawtuxet and Mishnock Rivers

Such acquisitions would benefit both hunters and wildlife enthusiasts.

Edges between forest, field, and wetland are often the most productive wildlife habitats. Some of the Study's major policies are the protection of prime agricultural soils, wetlands, unique natural areas (Category A and B Resources), and other critical lands. Actions to protect these resources – described in *Chapter 3 of the Regional Report* – have secondary benefits for the wildlife enthusiast or hunter because of the implications for wildlife productivity.

Fresh water resources abound in the Pawtuxet planning area. To ensure their usefulness to the fresh water fisherman, the Study recommends:

10. **Acquire public access to 29 ponds.** The Rhode Island Division of Fish and Wildlife through acquisition of public rights-of-way should guarantee public access for fishing to 29 ponds, twenty acres or larger identified in the Study's single-purpose inventory as having good and best fishing potential. The most important of these are:

Gloicester: Ponagansett Reservoir	Scituate: Peeptoad Pond, Betsey Pond
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Johnston:

Simmons Lower
Reservoir, Sim-
mons Upper
Reservoir, Almy
Reservoir, Oak
Swamp Reser-
voir, Kimball
Reservoir

Cranston:

Fenner Pond
Print Works
Pond, Randall
Pond

Coventry:

Barden Reser-
voir
Foster-Scituate
Carr Pond, Flat
River Reservoir,
Stump Pond,
Quidnick Reser-
voir, Tiogue
Lake

West Greenwich:

Carr Pond,
Mishnock Lake

Providence:

Roger Williams
Park Ponds

Foster:

Hopkins Mill
Pond, Westcon-
naug Reservoir

Scituate-Johnston:

Moswansicut

The SENE Regional Report has also recommended state ac-
quisition of fishing access to the Ponagansett River in Foster
and to the Flat River in Coventry, both of which have re-
gional value for fresh water fisheries production.

Creating new wetlands was not recommended in the short-
term because the high cost involved in initial outlay would
be better spent in preserving wetlands which already exist
and are known to be highly productive.

Implications

The combined recommendations for fresh water fishing
would meet at least 14 percent of the total 1990 demands.
The alternative of creating impoundments was not recom-
mended because of the high costs and low return on
satisfying total 1990 demands. While public sentiment
against expanding licensing programs is very strong, the
fact that many fishermen are unlicensed must be kept in
mind. Revenues gained from licensing fishermen 12 years
and older are important for expanding the planning area's
low productivity.

- 11. Acquire public access to 11 streams. The
Rhode Island Division of Fish and Wildlife
should provide public access to 11 streams
having good and best fishing potential identi-
fied in the Study's single-purpose-inventory.
The most important of these are:**

Cranston-Warwick:

Pawtuxet River

Cranston-Warwick:

Pawtuxet Cove

West Warwick:

North Branch
Pawtuxet River

West Warwick:

Pawtuxet River

Foster:

Barden Reservoir

Coventry:

South Branch
Pawtuxet River

**Coventry-West
Greenwich:**

Big River

Coventry:

Flat River Reservoir

West Greenwich:

Nooseneck River

Foster:

Dolly Cole Brook

RECREATIONAL BOATING

Recreational boating activities and needs at Pawtuxet Cove
are discussed in the *Narragansett Bay Planning Area Report*.

CHAPTER 7 MARINE MANAGEMENT

The few major marine-related issues relevant to the Pawtuxet planning area are covered in the *Narragansett Bay Planning Area Report*. Additional information on a wider perspective can be found in the *Regional Report, Chapter 7 on Marine Management*. That chapter covers, in specific fashion, sections on offshore fisheries, shellfish and aquaculture, port development, dredged materials disposal, offshore sand and gravel, and urban waterfronts.

Additional marine-related topics, such as recreational boating, beach swimming, coastal access and salt water sportfishing can be found in *Chapter 6 of the Narragansett Bay Planning Area Report or the Regional Report*. Similarly, discussions on power plant siting, including coastal sites, and regional petroleum needs, including coastal implications for tank farms, are to be found in *Chapter 9, Locating Key Facilities, of the Regional Report*.

CHAPTER 8 FLOODING AND EROSION

Riverine flooding in the Pawtuxet River planning area is some of the most serious of all ten planning areas in the SENE region. The flooding problem is intensified by lack of adequate wetlands to act as natural valley storage and by significant development in the basin. The 23 percent of the planning area (including Warwick) that has been developed (according to a 1971 study for the Rhode Island Water Resources Board) represents a significant percentage — approximately 20 percent — of the total land within the state devoted to residential, commercial, and manufacturing development. Most of this development has occurred in the lower reaches of the river in Cranston and Warwick. Warwick is presently the second largest city in Rhode Island and is projected by the Rhode Island Statewide Planning Program to remain so. Cranston is now the fourth largest city and is expected to grow to the third largest by 1990.

High rates of growth are projected for all seven Pawtuxet towns. These projections combined with good transportation access — particularly I-95, I-295, and P-37 — have generated high development pressure in the basin. The attractiveness of available open land for development has resulted in a continual reduction of the existing natural valley storage areas.

Open and wooded fresh water wetlands totalled some 13,000 acres in 1970. Most of these are in the western portion of the basin, where development has not encouraged the filling of wetlands to the extent it has in Johnston, Cranston, and Warwick. In the last decade, approximately 10 percent of the natural valley storage area along the mainstem of the Pawtuxet River was developed. The approximate flood plain area for a 100-year frequency storm is 16,000 acres. Of the 2,200 acres of flood plain along the mainstem (including Warwick), some 60 percent has been developed.

The Situation

Inland Flooding and Wetlands Protection

During the past century, the Pawtuxet River basin has experienced several storms of 50-year frequency, and many in the 5 to 10-year frequency range. Most of the low frequency events have occurred during the 1960's and early 1970's. Because the lower reaches of the basin are tidal, they are subject to both riverine and tidal flooding. As such, these lower reaches are much more susceptible to damages caused by a low frequency event when in combination with a normal high tide, thus reducing the ability of the river to

pass the fresh water flows into Pawtuxet Cove. This latter instance has occurred quite frequently in the past.

The greatest flood ever recorded in the watershed was that of February 1886. Other floods of significant magnitude occurred in March 1936, July 1938, March 1968, and February and April 1970. It should be noted, however, that the 1886 flood occurred prior to the construction of Scituate Reservoir which, although a water supply reservoir, helps to retain flood flows. In addition to major flooding, overflows into low lying areas during spring runoff result in almost annual nuisance conditions.

High flows in the river are reduced due to the modifying effects of two reservoirs, Scituate and Flat River, though neither was designed to provide flood storage. These two reservoirs control about 150 square miles of the watershed, or about 65 percent of the total basin. It has only been fortunate that when damages have been experienced downstream, the storm hit at a time when these reservoirs were not at capacity. Had the March 1968 flood hit when the reservoirs were full, downstream damage would have increased sevenfold.

Scituate Reservoir, a water supply reservoir complex, was at a low condition when most of the major storms occurred. Significant volumes of water can be stored in the actual water supply portion, and another significant volume can then be temporarily retained in the surcharge portion of the reservoir. Scituate Reservoir has a drainage area of 92.8 square miles or 40 percent of the basin. The North Branch originates at the dam, which is located in Scituate.

Flat River reservoir is used principally for low flow augmentation for downstream industrial usage. The principal modifying effect created by this reservoir is surcharge storage of the flood flows. It has a drainage area of about 57 square miles, or an additional 25 percent of the basin. The dam creating the impoundment also is the origin of the South Branch and is located in Coventry.

There are a total of 80 lakes and ponds, the greatest number for all Rhode Island basins. They total 11 square miles of surface area and they provide an additional modifying effect on flooding. There are a total of 23 dams on the mainstem and the North and South Branches of the Pawtuxet River. Many of the dams are no longer operated, or in some cases, the water impounded behind the dams is only used for fire protection. Several of the industrial water rights are still actively exercised by regulating dam impoundments for industrial processes. There are three significant dams (Pawtuxet, Pontiac, and Natick) that are located on the mainstem.

Pawtuxet Dam, located immediately upstream from the Broad Street Bridge in Cranston and Warwick near the mouth of the river, was constructed to prohibit normal tidal interchange on the lower reach of the river and to reduce the impact of tidal flooding in this lower reach. Pontiac Dam, located at river mile 7.3, and Natick Dam (the largest on the mainstem) located at river mile 9.8 are old mill dams.

On both the North and South Branches, the low lying land, once a sprawling area with many flood plains, is now occupied by randomly dispersed residential areas, commercial areas, and industrial plants. Along the North Branch, four industrial areas and one commercial area were subjected to nuisance damages from the March 1968 flood. Eight industrial, two commercial, and two residential areas were similarly affected along the South Branch. All are prone to serious damages from a larger storm. It must be reiterated that flood stages will increase due to urbanization, especially along the South Branch. However, damages from the confluence of the North and South Branches upstream to their respective origins from a 100-year event would probably not exceed \$1 million including projected growth.

Other areas of urban sprawl are along Meshanticut Brook and the Pocasset River in the towns of Cranston and Johnson. The construction of I-295 within the lowlands along Meshanticut Brook has resulted not only in a loss of natural valley storage, but also relocation of the brook through a culvert of limited capacity. This culvert then would act as a dam causing a back-up of water at high frequency events. This would then result in the brook short circuiting its streambed and flowing overland behind the Warwick Mall and then flowing into the Pawtuxet just above Pontiac Dam. The Pocasset River is undergoing similar changes. Here, many natural valley storage areas are being filled and developed for industrial, commercial, and residential use. Restrictions at bridge and culvert openings will compound future flood problems.

Flood problems along the Pocasset River and Meshanticut Brook are presently of a more local character and result in minor losses. Along the Pocasset River, a storm having a frequency of occurrence of once in 100 years would cause damages to 57 homes, five commercial establishments, and five industries. About ten homes, four commercial, and three industrial operations would receive damages from a similar occurrence along Meshanticut Brook. Unless careful flood plain management and enforcement of a 100-year flood plain is initiated, the magnitude of damages on these two watercourses will become as startling as those in the mainstem.

A detailed flood damage survey has been completed by the Corps of Engineers along the mainstem and the South Branch of the Pawtuxet River. The table below is a presentation of the total damages that would be caused by the occurrence of the indicated event at present (1972) and in 1990 for the mainstem. Both figures are at the same dollar value and represent damages to the same buildings and their contents, i.e., no new growth. Thus the increase in damages represents the change in flood stage created mainly by urbanization.

The Corps of Engineers has estimated that growth in the flood plain from 1972 to 1985 will probably take place at the following rates: 4.4 acres per year of residential growth; 3 acres per year of industrial growth; and 5.1 acres per year of commercial growth. Without re-zoning, the commercial land available in the flood plain will be completely developed by 1980.

Current criteria for determining monetary losses due to growth require that all buildings be protected from the 100-year flood. However, even if the 1970 100-year flood plain were delineated and all new development below that level were flood proofed, it would not be possible to stop development in the flood plain above that 1970 100-year flood level. It is assumed that past growth rates in the flood plain would continue in the areas immediately above the 1970 delineated flood plain. Assuming enforcement of the 1970 100-year flood plain and the growth rates described above, it is anticipated that a 100-year frequency storm in 1990 with flood stages higher than the same frequency event in 1970, would cause an additional \$7.3 million of damages to new industrial operations; \$500,000 damage to new residential areas; and \$1.3 million of damages to new commercial establishments. This represents damage to development outside the 1970, 100-year flood plain but inside the 1990, 100-year flood plain. However, the 100-year flood plain is not at present being enforced. Since the damage survey, significant development has occurred at Bulova Watch Company and in Warwick Industrial Park. All of these areas are subject to flooding from 15-year events. Without strict adherence to the 100-year flood plain, future damages caused by a major event could be catastrophic.

TABLE 8.1 PAWTUXET: ESTIMATED FLOOD DAMAGES WITHOUT GROWTH

Event	1972	1990
5 - year frequency	\$ 203,000	\$ 267,000
20 - year frequency	1,546,000	2,332,000
50 - year frequency	6,892,000	9,468,000
100 - year frequency	14,815,000	17,930,000

Inland Erosion

Major erosion problems in this planning area have been identified on some 350 acres of agricultural land, 250 acres undergoing commercial development, and 40 miles of road bank cut slopes. Also, there are sediment problems resulting from these erosion sources and others on small amounts of cropland, land undergoing urban development, and in swamps, ditches, catch basins, and streams. Additional erosion and sedimentation problems are occurring on some logging roads and unstable stream banks. It is expected that much of the erosion damages can be avoided through a sound urban-environmental forestry program to retain as much of the native vegetation as possible.

Tidal Flooding and Coastal Erosion

Despite the small area subject to tidal flooding and coastal erosion — only about 2 miles in Warwick and Cranston — there are a number of problems resulting from tidal flooding, scattered non-critical shoreline erosion, and siltation of the navigation channel. Tidal flooding can cause serious backwater flood problems in the lower Pawtuxet, even more so when hurricane tides are synchronized with riverine flood flows. The possibility of providing protection to minimize the resulting damage is being studied as part of the ongoing Corps of Engineers Pawcatuck-Narragansett Bay Study. Coastal erosion occurs at less than 3 feet per year, making it “non-critical”, and needs for further protection can be remedied by local and individual protective structures.

Pawtuxet Cove is well protected from storm wave action by Washouset Point and the 2,200 foot long breakwater (completed in 1966 for recreational boating). In general, the shoreline is composed of individual concrete and rock seawalls, rock revetments, timber bulkheads, a small tidal marsh, and natural unprotected sections.

The Cove is susceptible to some hurricane tidal flooding from Narragansett Bay; damages are confined to boats and low-lying buildings. Although some of the existing shoreline structures are in various stages of disrepair, they have been fairly effective in providing protection from erosion. Fresh water flooding in the cove, from the Pawtuxet River, is not critical. However, silting of the navigation channel and pollution are still major problems.

There are only approximately 10 acres of coastal wetlands in the planning area, in Warwick. Those few wetlands not already protected in the Salter Grove Park should be protected.

Ongoing Programs

There are a number of ongoing programs dealing with flood control and flood plain management. Among these are: the National Flood Insurance Program of the Department of Housing and Urban development; flood and storm forecasting and warning services of the National Weather Service; Section 205, of the 1948 Flood Control Act as amended, which authorizes the Corps of Engineers to prepare flood control studies and projects; and mapping services of the Corps of Engineers, Soil Conservation Service (in the U. S. Department of Agriculture), and the U. S. Geological Survey. In addition, the following two major programs are ongoing in the planning area.

PNB. The Pawcatuck River-Narragansett Bay Drainage Basins (PNB) Urban Study is an expansion of a level C flood control study now in progress by the New England Division of the Corps of Engineers for flood control and allied purposes. The purpose of an urban study is to provide federal assistance in resolving regional water resource problems, and to develop alternative plans that may be selected by state and local officials as components of a comprehensive urban area plan. Study elements include urban flood control and flood plain management and estuarine flood protection, as well as municipal and industrial water supply, navigation, water related recreation, and conservation of fish and wildlife resources.

The Corps of Engineers is presently considering three flood control projects on the lower Pawtuxet River. The first of these is a diversion of flood flows from just downstream of the Natick Dam to Apponaug Cove. This diversion would consist of a 30-foot diameter tunnel through bedrock for a distance of approximately 13,000 feet. Virtually no land taking would be involved because the entire project would be underground with the exception of the intake and outlet structures. The project would be capable of diverting up to 13,000 cubic feet per second against a 10 foot tide, which is equal to approximately 75 percent of the standard project flood. The standard project flood (SPF) is defined as the most severe probable flood that could likely occur in a basin, under the worst combination of conditions. Under normal conditions, the Pawtuxet River flow would not be diverted, and the flow would be the same as without the project. When flows increased during flood periods, flows in excess of normal flows would be diverted through the tunnel to Apponaug Cove. At least one environmental impact of this project would be a lowering of the Cove's water quality, currently at “B” status. It is expected that the diversion would have to be operated about once a year with average flows of about 200 to 300 cfs being diverted. The project would provide 100 percent flood protection

to areas immediately downstream from the intake structure, with the percent protection decreasing further downstream because of flows being contributed by tributaries downstream from the diversion. Initial estimates indicate that the project could cost up to \$45 million with a fully lined tunnel.

The second project being considered is a local protection project at the Warwick Industrial Park. This project would consist of a series of earth dikes and concrete walls to provide total flood protection against the SPF for industrial, commercial, and residential properties in the vicinity of the Warwick Industrial Park. This project would be economically feasible and necessary whether or not the diversion project is constructed. However, if the diversion is constructed, the walls and dikes will not have to be as high because of the reduction in flood heights caused by the diversion. The project will consist of approximately 6,500 feet of walls and dikes and is expected to cost approximately \$6 million.

The third project being considered is a local protection project at the Norwood Residential Area in Warwick. This project would consist of a rock-filled dike to provide flood protection against the SPF. The rock used to construct the dike would come from the construction of the proposed upstream diversion tunnel, thus reducing the cost of the project. The project will consist of approximately 5,000 feet of rock dike and is expected to cost approximately \$2.5 million.

An alternative proposal considered by the PNB Study would entail local protection by provision of earth dikes to provide total flood protection to the Bulova Watch Company against the SPF. This project *will not be needed if the diversion is constructed* because the diversion would be able to provide 100 percent protection for this area. If constructed, the project would consist of about 2,000 feet of dike and is expected to cost approximately \$1 million.

A second alternative considered by the PNB Study would entail increasing the height of the proposed Big River water supply reservoir. If the water supply dam proposed by the State of Rhode Island is raised 2 1/2 feet, adequate flood control storage could be provided to prevent flood damage along the South Branch of the Pawtuxet River. It would not be feasible to construct the reservoir only for flood control, but studies indicate the incremental cost of raising the proposed water supply dam would be economically justified. It is expected that these costs would be in the range of \$2.5 million, but will depend to a great extent on design criteria for the dam itself. The benefits which could be obtained from such an effort will probably be worthwhile and they should be explored by the State of Rhode Island.

RC & D. The Rhode Island Resource Conservation and development Program (RC & D) covers all Rhode Island municipalities. The plan for the project area is designed to set forth opportunities for economic growth resulting from the development, conservation, and utilization of the natural resources of the area. Up to 100 percent of technical and construction costs can be made available for flood prevention structures and land stabilization.

The Solutions

Alternatives

There are three basic approaches which can be used to reduce or eliminate flood damages in the Pawtuxet River basin. One method is to institute control over the river, a second is to establish control over the land, and a third is to affect the structures and people already situated in the flood plains.

The major types of structural control measures applicable to the Pawtuxet River basin are floodwater diversions, walls and dikes, and dams and reservoirs.

Single-purpose flood control reservoirs were not considered feasible because the major damage areas are concentrated near the mouth of the river. The Pontiac Diversion, channeling excess flood flows to Apponaug Cove, and the Pontiac Dam, replacing the existing dam, were considered but not recommended. Other types of structural measures considered were the removal of dams (reduces upstream river stages); channel improvement (allows a larger volume of water to be contained in the channel without flooding); flood proofing (reduces existing damages by preventing water from entering existing buildings with measures such as bricking up cellar windows); and urban redevelopment.

Flood damages in the Pawtuxet River basin can also be partially reduced by establishing controls over land use, including flood plain zoning, sub-division regulations, and building code restrictions.

Flood damages in the Pawtuxet can also be reduced by affecting the structures and people already situated in the flood plain. Among the measures which can be taken are flood proofing, improved and expanded storm and flood forecasting and warning services, temporary evacuations, and permanent removal of existing structures from the flood plain.

There is no feasible alternative for controlling tidal flooding entirely. This would entail a barrier of large proportion to prevent tidal encroachment, a very large pumping station capable of passing the fresh water flows of the Pawtuxet

River into the Pawtuxet Cove, and major channel improvements to allow the river to contain a larger volume of flow without causing overrunning of its banks.

It should be noted again that even by controlling growth in the flood plain, greater damages will be caused in the future to the existing flood plain due to higher river stages. This is due to increased urbanization inland, away from the flood plain. Where land was once vacant, it is now replaced by new streets and subdivisions causing an increase in run-off during and after storms. This run-off then leads to higher volumes of flows in the river for the same frequency storm.

There is no single structural or non-structural solution to the flooding problems, existing or contemplated, for the Pawtuxet River Basin. Any flood protection scheme that is selected for this basin must prevent flood damages by removing, retarding, or containing flood plain development along the mainstem and tributaries, as well as examining structural measures. As has been stated earlier, it is not economically feasible to control a major contributing factor to the flood problems of the lower basin, that factor being tidal problems.

Recommendations

In general, the Study's recommendations emphasize that both inland and coastal flood plain areas should be protected from development by using non-structural solutions such as maximum protection of wetlands and strict development criteria wherever possible. Only where there is high-value development in small concentrated areas should development be protected from flooding, coastal or otherwise, by using structural solutions.

Because the Corps of Engineers is now conducting public hearings to obtain citizen input on the specific project proposals described under the PNB discussion above, the SENE Study will concentrate on several other areas.

A major result of the SENE Study has been the classification of the region's resources according to their capability. Inland and coastal wetlands and estuaries have been classified as "A" resources, requiring the greatest degree of protection from development. Flood plains and hazardous coastal flooding areas (both to the 100-year flood frequency line) have been classified as "B" resources or management areas, which have very limited tolerance for development, but with proper management are suitable for such compatible activities as agriculture or recreation.

In keeping with these resource classifications, it has been recommended that comprehensive flood plain management programs be developed for flood prone areas, making use of non-structural solutions wherever possible. All such programs should be developed in close cooperation between federal and state agencies, and local governments and inter-

ests. They should also be coordinated with related programs, such as the National Flood Insurance Program, flood warning services of the National Weather Service (when adequate warning time for this basin is available), state wetlands acts, state land use planning programs, and, for coastal areas, with state coastal zone management programs.

An important recent development is the enactment of Section 73 of the Water Resources Development Act of 1974 which authorizes federal cost sharing for non-structural measures. Although implementation of Section 73 has presently been deferred by OMB (Office of Management and Budget), application of the cost sharing authority can be an important factor in making non-structural solutions more competitive than they have been. The ongoing PNB and RC & D programs offer the potential opportunity for federal cost sharing in non-structural as well as structural solutions.

Therefore,

1. **Assess current programs to give non-structural emphasis.** The Corps of Engineers, Soil Conservation Service, and other sponsoring and participating agencies should evaluate the possibility of federal participation in implementing non-structural solutions for the Pawtuxet basin as part of the PNB and RC & D programs.

Recommended projects under both programs should include consideration of regulation of existing dams, bridge and culvert reconstruction, and improved flood forecasting which together may prove to be valuable additions to structural proposals. A combination of strong flood plain zoning, wetlands protection, flood proofing and flood warning, along with regulation of existing dams and bridge and culvert reconstruction, should be considered for federal funding participation under authority of Section 73.

In coordination with the PNB and RC & D programs and as a condition for future federal financial assistance:

2. **Adopt local flood plain zoning to regulate future flood plain development.** Municipalities should adopt flood plain zoning to regulate further development in flood prone areas (and particularly in the 100-year floodway).

This also includes incorporating inland and coastal wetlands, eroding areas, and storms of record on the map upon which the zoning is based. All related regulations — building codes, subdivision regulations, sanitary codes — should reinforce this policy of regulating new development and redevelopment in the 100-year flood plain. The regulations should

also take advantage of the restrictive provisions of state wetlands regulations, scenic rivers programs, and the like.

Related to local zoning action are two recommendations for controlling local sedimentation and inland erosion problems.

- 3. Establish local sediment and erosion control ordinances.** Municipalities, assisted by the U. S. Department of Agriculture and the Department of Natural Resources, should establish local sediment and erosion control ordinances.

A model for such ordinances is included in the more detailed information prepared for the Study and available at NERBC.

- 4. Establish forest buffer zones.** Municipalities should establish appropriate forest buffer zones within 200 feet of streams and lakes to preserve vegetation and maintain natural systems through forestry techniques to help keep non-point source pollutants from reaching sensitive water quality areas.
- 5. Control forest land erosion.** Landowners should control forest land erosion by proper road location and stabilization activities such as seeding and ditching.

Cooperative federal, state, and local programs are available to implement this solution.

Towns with existing high and medium-high development pressure (*see Chapter 3, Guiding Growth*) should be among the first to implement these recommendations. These towns are Johnston, Coventry, and Scituate.

In conjunction with a zoning program:

- 6. Acquire key wetlands and flood plains.** Municipalities and state agencies should investigate continuing possibilities to acquire those wetlands and flood plain areas most significant for flood damage reduction and protection, and which have water supply, wildlife, and/or recreation values.

Particular emphasis should be given to protection of areas classified as unique natural areas and those wetlands/flood plains located in areas subject to high and medium-high development pressure as noted above.

More specific actions regarding wetlands protection are included in *Chapter 8 of the Regional Report*. Protection of wetlands and flood plains is also expected to help existing structural flood protection projects do their job by keeping flood flows to within the design capacity of the existing dams, channels, etc.

In built-up and heavily used areas such as in Cranston and Warwick, alternative locations outside the flood plain may not be feasible.

- 7. Locate in existing safe buildings in the flood plain.** Where location outside the flood plain is not feasible, municipalities should encourage private interests to locate in existing safe buildings in the flood plain, rather than permitting adverse construction in the flood plain.

Flood proofing, especially of existing buildings, is particularly appropriate where only moderate flooding is expected, where other types of flood protection are not feasible or where activities on waterfront location need some degree of protection. Improved and expanded storm and flood forecasting and warning services, recommended in *Chapter 8 of the Regional Report*, will also be important in keeping down future damage costs.

Implications

This approach is a good deal more restrictive than the National Flood Insurance Program requires. But it does make full recognition of resource limitations and natural functions of wetland and flood plain areas. The SENE Study has found that all new development can be accommodated in C, F, and G lands (*as discussed in Chapter 3*) so that protecting A and B lands from inappropriate use need not be incompatible with a growing economy. In fact, a policy of resource protection and non-structural solutions is regarded as a significant step toward protecting the region's fragile resources, which is expected to be in the long-term interest of the SENE region.

CHAPTER 9 LOCATING KEY FACILITIES

One of the most difficult issues to grapple with at the local level is the siting and operation of such key facilities as power plants and mineral extraction activities. While the former is not a significant issue in this planning area, the latter is.

SAND AND GRAVEL EXTRACTION

Production of sand and gravel in the Pawtuxet planning area is a significant segment of Rhode Island's mineral economy. According to the state's aggregate survey, reserves in the area total 14.2 million cubic yards, the vast majority of which are located in the towns of Coventry and West Greenwich.

Output has been fairly steady for the past several years, accounting for 50 percent of the state's total production and valued in 1970 at \$2.9 million. The development pressure maps (*Chapter 3, Regional Report*) show that development pressures in the key towns, now predominantly rural, will significantly increase in the near future. Thus, while development pressure on the two key towns is still only moderate, a unique opportunity exists to assure the preservation of known deposits for future use.

Existing town zoning ordinances, however, provide only basic permitting and in some cases performance regulations, and do not currently demand rehabilitation or

provide for sequential use of identified sites with first priority use for mineral extraction.

Given the prohibitive cost of imported aggregate and the current unfeasibility of marine extraction, the details of which are examined in *Chapters 7 and 9 of the Regional Report*, the state clearly has no alternative than to protect and plan for the use of this valuable resource.

Rigorously pursued, the recommendations made for each state in *Chapter 9 of the Regional Report* will be sufficient to guarantee the protection of significant mineral deposit sites and regulate extraction operations in the Pawtuxet planning area. Specifically, the recommendations provide for state-established operating standards under a local land use approval system, provide for a standard permitting procedure for all extraction operations, and guarantee site reclamation. With sites already identified by the Rhode Island Aggregate Survey, a system of sequential uses of mineral deposit lands established, and strong regulations for operations and reclamation, adequate sand and gravel can be produced to meet both planning area and state needs at the least economic and environmental cost to residents.

While the techniques described above will be useful in terms of dealing with sand and gravel extraction, significant deposits are reported present at the site of the proposed Big River Reservoir. Mining sand and gravel during reservoir construction before flooding can avoid the loss of a significant resource.

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